TECHNOLOGIES OF INSCRIPTION: ARCHIVAL ITERABILITY AND THE SEMIOTICS OF GENOMIC LANGUAGE

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2002

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For Thomas, Alexander, and Nicole

ACKNOWLEDGMENTS

First, I must thank Tom, my husband, for relocating his business so that I could continue my education. Without his ongoing support and love I would never have been able to return to school. Second, I must thank my parents, Robert and Rachel, for regularly traveling hundreds of miles to play with their grandchildren and give me some time in "writer's camp" to finish the dissertation. Without their ongoing support and love I would never have completed this text. Third, I must thank my children, Alexander and Nicole, for being their fabulously entertaining and inspiring selves. They are the joy of my life. Fourth, I must thank my committee for their patience and their commitment to my success. Their helpful advice on the manuscript has made this a better text than it could otherwise have been. Heartfelt thanks go to Dr. Daniel Cottom at the University of Oklahoma, Dr. Harry Paul in the history department here at the University of Florida, and especially to Dr. John Leavey, chair of both my committee and the English Department, and to Dr. Phillip Wegner, from whose teaching the idea for this dissertation grew.

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Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree Doctor of Philosophy

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MAY 2002

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This dissertation proposes to take the metaphorical description of DNA as language seriously to examine what this rhetoric can tell us about language, about the scientific investigation of DNA, and about the biopower they generate. It examines how DNA, scientific knowledge, and the social and legal subject are all produced through iterable processes of archivization analogous to those that produce language. These processes work as technologies of inscription that generate systems of difference whose stochastic accrual of pattern generates a distributed agency. Furthermore, this dissertation calls for revision of our understanding of justice to recognize the full consequences of this shift from the liberal humanist subject to a posthumanist subject with distributed agency, particularly in regard to questions of property.

Chapter 1 introduces the main concepts that will be engaged throughout the dissertation, particularly how the difficulties of translation impinge on this project as it seeks to juxtapose the discourses from many different disciplines. Chapter 2 focuses first on the type of knowledge scientific study produces by reviewing the work of historians and philosophers of science to illustrate the consequences that follow from recognition of the historicity of science, and second on negotiating a position from which to pursue investigations of the rhetoric mobilized by DNA and the institutions engaged in its socialization. Chapter 3 examines the role of linguistic metaphors in shaping DNA research and rhetorics and how these rhetorics engage the central problems in the study of language as it confronts the consequences of linguistic citationality. Chapter 4 focuses first on processes of genetic archivization in the socialization of DNA, and then on how the transgenic writing practices of global capital enable the Taylorist management of molecular life to provide a rationale for increased public involvement in the future course of biotechnology. Chapter 5 examines how biotechnology is confronting courts and legislatures with challenges to liberal humanist subjectivity and argues for a posthumanist construction of the subject that facilitates the possibility of a justice redefined to face the implications of archival iterability. Chapter 6 considers the implications of this redefinition of justice for a variety of social institutions.

CHAPTER 1
INTRODUCTION: SCENES OF TRANSLATION

This story recounts, among other things, the origin of the confusion of tongues, the irreducible multiplicity of idioms, the necessary and impossible task of translation, its necessity as *impossibility.* – Jacques Derrida, *Des Tours De Babel*

When God imposes and opposes his name, he ruptures the rational transparency but interrupts also the colonial violence or the linguistic imperialism. He destines them to translation, he subjects them to the law of a translation both necessary and impossible. . . . – Jacques Derrida, *Des Tours De Babel*

What is DNA? While it is certainly a biochemical structure important in performing the miracle of life via the formation of proteins and enzymes in living organisms, it is clearly much more. DNA is a twenty-first century icon mobilized in a variety of discourses. It is an active site in the formation and circulation of knowledge and power in scientific, medical, legal, economic, social, literary, and artistic fields. One of the central metaphors shaping DNA research, and hence DNA's larger cultural impact, is the notion that DNA functions as the "language of life." Thus genomes are variously described as "the book of life," "the code of codes," and as "blueprints," "information," "lexicons," and "encyclopedias." In trying to understand the vast quantities of information produced by the Human

Genome Project, some researchers are even using "grammar rules and other aspects of computational linguistics to sort out genes and their function" (Pennisi 450). The language metaphor is thus more than just a way of explaining DNA to the public. Thinking of DNA as a biochemical language that we are learning to read by learning to write has important implications for the nature of the knowledge produced in DNA research and for the ways in which DNA becomes a cultural actant. DNA is both a physical material and a rhetorical focus, a node of action where many discourses and actants engage each other to generate and modify bodies, knowledge systems, and power distributions.

With the acclaimed recent completion of its human DNA sequence, the Human Genome Project is foregrounding the role of DNA research as *the* location of progress in medicine's search for cures, in business's search for profitable patents, in the court's search for accurate interpretations of forensic evidence, even in philosophic and artistic investigations of meaning. What are the likely consequences of this foregrounding? What translations of DNA are occurring among genetic, evolutionary, medical, legal, economic, literary and artistic discourses and what can these circulations of reference tell us? What are the limits and boundaries that these circulations perform or enable? How are language, communication, and translation to be understood when they are used to describe what genetic material does and what we do with it? What are the consequences of using these terms in this way? Moreover, what is the role played by genetic archivization in western institutions and knowledge systems? How will our laws and philosophies come to grips with the many implications that learning to "read" and "write" with DNA will have for civil society? These are some of the questions

this dissertation will seek to address by examining how the variety of discourses engaged in socializing DNA and DNA itself function as technologies of inscription.

The vast quantities of information produced by the Human Genome Project will require an understanding of the problematic nature of translation and less grandiose knowledge claims on the part of some science advocates. Despite frequent hyperbole to the contrary, DNA does not fully determine human potentials because it is only one of the many actants engaged in shaping the physical and rhetorical networks in which it and we circulate. DNA molecules are no more the full masters of their rhetorical and bodily expressions than we are. Like us they come into being and function via the forms provided by the stochastic accretion of patterns in a variety of physical substrates, and their agency is as distributed among these forms and patterns as ours is. DNA does not create us *ex nihilo*. Nor does language generate our thoughts *ex nihilo*. Both require corporeal embodiment and an ongoing interaction with other material and rhetorical technologies of inscription. For DNA to engage in the process of creation that we call the miracle of life, it must interact with the mechanisms of the cell, the organism, and the ecosystem at large in the ongoing co-production of cells, organisms, and ecosystems. For language to engage the process of creation that we call consciousness, it must interact with the mechanisms of the brain, body, society, and physical world in the ongoing co-production of brain, body, society, and physical world.

This dissertation proposes to take the metaphors used to translate among discourses seriously and will examine how linguistic theories, particularly the problematic nature of translation, might offer useful insight for genome reading

strategies and for understanding the variety of ways DNA functions as an actant in human culture. The challenge in using linguistic metaphors to describe and investigate the dynamics of DNA is that one's understanding of language will lead those descriptions and that research in particular directions. If one understands language as a simple system of unproblematic signification, a transparently referential system of signs and their objects, what is erased in the use of linguistic metaphors for DNA are the full consequences of the citationality of language. A poststructural understanding of language, on the other hand, offers a way of looking at the actions of "reading" and "writing" that takes both the semantic import of grammatical categories and embodiment into account. This understanding of the value of poststructural or postmodern thought finds that it does more than look at everything as a question of language. By examining both linguistic and biochemical generative processes as iterable systems I do not intend to simply subsume the biologic under the linguistic. I do argue that both linguistic and genomic expression are technologies of inscription, iterable structures that operate via a citational process that makes questions about the nature of translation fundamental to understanding both systems. I also hope to show that despite our ability to generate reinscriptions through these citational processes we do not fully control their meanings or effects because ours are not the only agencies at work.

By examining both language and DNA with a knowledge of poststructural theory, I hope to explain the consequences of iterability for both the creation of meaning and the creation of biochemical bodies. A poststructural understanding of language and DNA as iterable processes of stochastic accretion does not preclude scientists from "reading" and "writing" with DNA any more than it precludes us

from thinking with language. This citationality is, in fact, the very reason that we can write with both systems. As Jacques Derrida argues in "Signature Event Context":

> the possibility of disengagement and citational graft which belongs to the structure of every mark, spoken or written, and which constitutes every mark in writing before and outside of every horizon of semio-linguistic communication. . . . does not imply that the mark is valid outside of a context, but on the contrary that there are only contexts without any center or absolute anchorage [*ancrage*]. This citationality, this duplication or duplicity, this iterability of the mark is nether an accident nor an anomaly, it is that (normal/abnormal) without which a mark could not even have a function called "normal." (12)

It is in fact precisely because language and DNA are iterable processes, open systems in which the elements can be fragmented and recombined into new patterns, that such reinscriptions as "reading" and "writing" are possible. Moreover, these iterable systems are not closed, as translations among DNA and human languages and cultures occur through a variety of archival technologies such that identifying what is proper to DNA, to language, or to culture is problematic. By focusing on the iterable structure of both DNA and language and their efficacy as technologies of inscription that we use to shape our relationships with the material world and with each other rather than on language as a generator or carrier of "meaning" or on DNA as the generator or carrier of "traits," I also hope to show how such terms as "meaning" and "traits" are based on a discourse of presence that denies the very iterability that makes languages and genomes work.

What a poststructural understanding of language helps us challenge is the notion that our ability to generate linguistic and genetic reinscriptions indicates our

mastery of the material as liberal humanist subjects in full control of our technologies of inscription. It does so by undermining the supposed foundation of all claims to mastery via a critique that illustrates the ultimate indeterminability of the full context for any such writing as well as by deconstructing the liberal humanist subject itself. Without understanding the full context, without the capacity to trace every variable that effects the contextual resonances of a particular piece of writing, mastery can never be achieved nor reasonably claimed. Yet while this indeterminability undermines all attempts at mastery, it is also the structural precondition that calls for such attempts. Again, as Derrida argues in *Des Tours De Babel*, we are semiotic agents for whom "translation becomes law, duty, and debt, but the debt one can no longer discharge" (226). The problem of translation applies as much to our thoughts as to our actions and words once we consider the consequences that follow from the radical alterity that inheres in such iterable processes as thought. Without the possibility of a liberal humanist subject who is fully at home with and in control of himself, agency becomes fractured as well and disseminates among people, things, and technologies. This dissertation seeks to address some of the consequences of that dissemination of agency for our concept of justice and to propose an alternative that recognizes the consequences that follow from iterability, particularly in relation to questions of property.

In order to investigate the role of DNA in these varied discourses, this dissertation must transgress disciplinary boundaries to follow the network of information and embodiments within which DNA performs. The hope of this dissertation is that such cross-disciplinary study can offer important insight on the circulations of DNA, both in terms of patterns in DNA research and in terms of the

socialization of DNA as an actant in contemporary culture. And yet, these are complex networks of signification, and tracing the mobilizations of DNA through them will, like any act of translation, face familiar difficulties. In translations designed to cross disciplinary boundaries or to move between a non-verbal language and a verbal one, we must recognize that rewording, even through synonyms, does not offer complete equivalence of message. As any translator knows, it is often impossible to translate certain words or phrases from one language into another and an approximation must be made that honors as much of the original's substance and style as possible but can be understood within the context of the language into which it is being translated. Moreover, even when translating seemingly simple terms which have conceptual equivalents in both languages, these equivalent terms do not engage all of the same valences within the often very different cultures that are co-produced with their langauges. Equivalencies are not identities. Moreover, as Derrida has argued, even within a language it is difficult to say what constitutes its borders and where the chains of signification end. In *Des Tours De Babel* he points out that earlier theories of translation failed to account for "the possibility for languages to be implicated *more than two* in a text" so that the process of translation is already a part of the original text and the challenge for anyone who would translate such a text is to render that plurality of languages (223).

Often the only way to respond to these fundamental differences in the forms particular languages and discourses enable and the variety of connections they make within cultures and languages is to discuss the problem at some length (generally in the translator's introduction or epilogue) with the hope that such an extended discussion of what cannot be fully translated will in some way help the

reader understand the nature of the problem faced. Another method for confronting these problems is to encourage the proliferation of translations so that the availability of many versions might offer a better understanding of the meanings and forms engaged by the original text. In many ways this dissertation could be described as an extended translator's introduction to the discourses engaged in socializing DNA. As such it too is faced with the problems of translation, context, and the indeterminability of meaning. Nevertheless, I will attempt to circulate approximate translations of DNA's role in a variety of discourses by taking into account the problematics of translation and citationality. I do so in the hope that this juxtaposition of the rhetorics used to socialize DNA will facilitate a new vision of justice based on the distributed agency of a posthumanist subject.

The ambiguity inherent in translating a text is also something genetic researchers are currently learning to deal with. As most scientists working in the trenches know full well, the kind of knowledge science produces is generally tentative, relational, investigatorial, and dependent upon the validity of a variety of other disciplines, processes, and technologies. Geneticists have found that genes often have multiple meanings, or rather, that they can express a variety of molecular structures depending upon the context of their expression. Genes are polyvocal much as words contain a plurality of meanings that communicate differently depending on their context. Genes can also remain silent, in fact, many must be silenced in order for life to develop. Likewise, as Ortega Y Gasset argues, "The fact is that the stupendous reality, which is language, will not be understood at its root if one doesn't begin by noticing that speech is composed above all of silences. . . . And each language is a different equation of statements and silences. All peoples

silence some things in order to be able to say others" (104). Bruno Latour has similarly argued in *Pandora's Hope* that the connection between scientific statements and reality is also a question of silencing some things in order to gain the ability to speak about others. I will come back to Latour's work in chapter 2, but it will suffice for now to say that what Latour calls the "radical realism" that science studies offers science is similar to the kind of approximation translators produce under the name of the original text.

We can often learn as much from the difficulties and silences as from the overt content in any text, and my own is no exception. In producing these approximate translations of DNA discourse, my own language must also leave many silences in order to bring into being an analysis of the common difficulties to be found as these disparate discourses face the problem of translation. I have not always been able to find language that would get around the use of terms that seem to presume that context is knowable, language determinate, and agency identifiable with a single and unified subjectivity. It is not my intention to use language in this way, however, I am not the only agent putting this dissertation together. The English language as I have come to know it, as well as the various disciplinary constraints engaged by the discourses I examine, all pull what is supposed to be solely "my" language toward their own valences. Again, I shall, nevertheless, attempt to juxtapose these approximate translations of DNA discourse while taking into account the problematics of translation and citationality to generate a posthumanist understanding of justice.

Before embarking on this analysis of the many translations of DNA, however, it will be necessary to review some of the work that has been done

concerning the historicity of scientific knowledge and the role of science as an institution in human cultures. Hence, chapter 2 focuses first on the type of knowledge scientific study produces by reviewing the work of prominent historians and philosophers of science to illustrate the consequences that follow from recognition of the historicity of science, and second on negotiating a position from which to pursue investigations of the rhetoric mobilized by DNA and the institutions engaged in its socialization. Chapter 3 examines the role of linguistic metaphors in shaping DNA research and rhetorics, as well as how these rhetorics engage the central problems in the study of language as it confronts the consequences of linguistic citationality. Chapter 4 focuses first on the role of genetic archivization in the socialization of DNA, and then on how the transgenic writing practices of global capital enable the Taylorist management of molecular life to provide a rationale for increased public involvement in the future course of biotechnology. Chapter 5 examines how biotechnology is confronting our courts and legislatures with challenges to liberal humanist subjectivity and argues for a posthumanist construction of the subject that facilitates the possibility of a justice redefined to face the implications of archival iterability. Chapter 6 considers the implications of this posthumanist redefinition of justice for a variety of human social institutions.

CHAPTER 2
TECHNOLOGIES OF INSCRIPTION: SCIENCE, HISTORICITY, AND THE PROBLEM OF CITATIONALITY

> Anamnesis *without* hypomnesis! *The archaeologist has succeeded in making the archive no longer serve any function.* It comes to efface itself, *it becomes transparent or unessential so as to let the origin present itself in person. Live, without mediation and without delay. Without even the memory of a translation, once the intense work of translation has succeeded.* – Jacques Derrida, *Archive Fever*

Despite being disciplines that seek to translate the natural world into systems of knowledge, disciplines that are thereby open to the problematics of translation, the sciences have long been portrayed as valiant explorations that reveal rather than create truth. Since the early 1960s, historians and philosophers of science have, however, developed a constructivist critique of scientific knowledge that tries to account for its historicity. In this chapter I will examine the development of the constructivist challenge to notions of objective science through the works of historians, philosophers, and science and technology studies scholars. Each approaches the problem differently, and these rhetorical differences have particular implications for questions of justice that will be considered. The sciences in general, and DNA research in particular, are clearly among the forces that shape ourselves and our world, but expecting any science to provide the truth about an

objectively determinable reality fails to account for the problem of translation and allows scientific knowledge a kind of authority that is unjustifiable. By opening scientific knowledge to consideration of the problematic nature of translation, constructivist theorists hope to make science less available to the rhetorics of dominance that rely on transparent access to truth. In doing so they are likewise engaged in the very real work of translation themselves.

How to Write the History of Science

In 1962 Thomas Kuhn published *The Structure of Scientific Revolutions* and began the constructivist challenge to the then traditional image of science as a steady march toward progress driven only by the desire for increasingly accurate knowledge. Kuhn argues that historians of science such as himself were confronted with the discontinuous development of scientific ideas and began to find it increasingly difficult to make the history of science fit "the concept of development-by-accumulation" expected of such endeavors (2). According to Kuhn, scientists work from paradigms that indicate the kinds of questions to be asked within a given field of study and designate what methods of investigation are expected to be the most useful. In Kuhn's analysis, scientific theories can be conceptualized to account for anomalous behavior only after such behavior has been identified, and anomalous behavior can only appear as such "against the background provided by the paradigm" (65).

This structure makes all paradigm shifts dependent upon "normal" science. Kuhn claims that "it is only through normal science that the professional community of scientists succeeds, first, in exploiting the potential scope and precision of the older paradigm and, then, in isolating the difficulty through the

study of which a new paradigm may emerge" (152). This notion that revolutionary science depends, necessarily, on normal science seems to recoup all paradigm shifts into the "development-by-accumulation" narrative that he is trying to dismantle. In this way Kuhn's paradigms offer a set of rules that operate as limit conditions that scientists use to mark off and examine their objects of study until those limits are exhausted and become too restrictive.

One of the most interesting things about Kuhn's argument is that he explicitly invokes Darwinian notions of "fitness," natural selection, and survival by adaptation in his explanation of scientific revolutions. First, paradigms must be fit to be selected: "Verification [of scientific theories] is like natural selection: it picks out the most viable among the actual alternatives in a particular historical situation" (146). While the "verification" of "viable" paradigms often seems to cause the extinction of other paradigms, the "historical situation" in which this victory and this extinction occur is a product of institutional power structures as much as it is a product of anomalous data. Kuhn seems to recognize this connection when he says that paradigms are selected "because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute" (23).

If it is the framing of the set of problems that is used to determine the "fitness" of the paradigm, it can be "fit" only in a very limited way that is already based in the values of those who are in a position to adopt it or let it founder. What values are involved in paradigm selection is an important question, and it is not easily answered by “scientific” values alone since those values are themselves part of larger epistemological systems. Kuhn argues that when a particular science is in

crisis, the members of that scientific community "resort to shared values" in their search for a new paradigm, and that "may be the community's way of distributing risk and assuring the long-term success of its enterprise" (186). This statement illustrates Kuhn's view that science adapts to new paradigms by making individual scientists and theories expendable.

For Kuhn science is the hero of this evolutionary tale as an institution with good survival strategies. He also argues that resistance to paradigm shifts is beneficial because "resistance guarantees that scientists will not be lightly distracted and that the anomalies that lead to paradigm change will penetrate existing knowledge to the core" (65). Resistance to revolutionary theories becomes part of the survival strategy because it makes science invest in each winning paradigm long enough to exhaust its productive possibilities as a map of the real. But what is the quality of the knowledge thus mapped? While it is a situated and contingent knowledge that is the product of a particular paradigm and a particular historical situation, it certainly claims to be a better understanding of the real. While no constructivist would argue that science fails to produce useful knowledge, the effects of its historicity must be examined.

For Kuhn, the "values" shared by scientists are those connected with their definition of science, non-contradiction and simplicity for example. And yet, there is epistemological content within even these values that remains unrecognized in Kuhn's analysis. Science is generally viewed as a process of experimentation and theory formation that produces truth by gathering facts and testing theories. Kuhn challenged this view to some extent by arguing that the "truth" science produces is transitory and that radical changes in science grow from the challenges anomalies

represent to the current paradigm rather than from systematic theory testing. Kuhn's approval of the values of non-contradiction and simplicity, however, leaves intact the notion that the truth about any object, force, or process studied is singular or essential as well as discoverable. It disallows paradox and plurality in the definition of knowledge. It also excludes the possibility that the perception of anomalous data may come from shifts in cultural values or power structures rather than from unexplained behavior on the part of newly revealed material or forces in nature.

Significantly, Kuhn argues that the development of any science is "a process of evolution from primitive beginnings–a process whose successive stages are characterized by an increasingly detailed and refined understanding of nature. But nothing . . . makes it a process of evolution toward anything" (170-1). This shows some of the difficulty Kuhn is having. He wants to question the notion that science is advancing toward truth, but at the same time he wants to show that science generates knowledge that is "systematic, time tested, and corrigible" (175). It seems that what Kuhn is trying to achieve is a notion of scientific progress as a powerful method of intervention in the natural world that provides truth claims about that world, but not one that is evolving to any point of perfect understanding. Kuhn finds it difficult, however, to relinquish the notion that we have progressed from the "primitive" to a "refined" knowledge of "nature." This slippage between progress as increased power to manipulate our environment and progress as increasingly accurate knowledge of a stable set of "natural" objects, forces, and processes is what keeps Kuhn in the realm of logical positivism.

In response to charges that his theory of paradigm shifts makes science too relativistic, Kuhn posits an "evolutionary tree" for the sciences where puzzle-solving ability has been cultivated and argues that "scientific development is, like biological, a unidirectional and irreversible process. Later scientific theories are better than earlier ones for solving puzzles in the often quite different environments to which they are applied" (206). Likewise, Kuhn says that what was truly revolutionary about Darwin's theory was that evolution was no longer "a goal-directed process" because "natural selection, operating in the given environment and with the actual organisms presently at hand, was responsible for the gradual but steady emergence of more elaborate, further articulated, and vastly more specialized organisms" (171-2).

And yet, the slippage in Kuhn's language implies that survival indicates not only "fitness" in a particular environment, but progress toward a more highly developed state. Although scientific progress will always require paradigmatic shifts in our understanding of the real, his language here seems to offer *de facto* legitimation for current scientific theories as the most explanatory and thereby the most accurate representations yet achieved. Science thereby remains a "goal-directed" process in that it seeks ever more accurate descriptions of the real. Kuhn says in a revealing line, "we posit the existence of stimuli to explain our perceptions of the world, and we posit their immutability to avoid both individual and social solipsism" (193). Of course, avoiding "solipsism" requires more than simply positing the existence of a stable reality. It requires that one posit one's ability to know that stable reality through one's experience.

For Kuhn, in order to speak scientifically, one must presume the possibility of objective data. It is the positivist connection to the real, through which science is both taught and popularized, that seems to legitimize science's truth claims. The only opportunity for delegitimation of a given paradigm in Kuhn's analysis lies in the ultimate instability of all data collection and interpretation. There are always new data, new technologies of viewing, new ways of selecting and analyzing what is viewed that will call into question current scientific theories. But more importantly, by making anomalous elements in nature the source of paradigm change, Kuhn fails to acknowledge the role of cultural influences in developing that new data and in changing how we view it. By looking to nature as the only source for information that can challenge the current paradigm, Kuhn makes what is true, and by implication what is correct or just, discoverable rather than created. While the power of science lies in its efficacy as a force we use to shape our environment, its efficacy does not necessarily prove its claims to be a truthful representation of the real.

Georges Canguilhem also confronts the "discontinuity" he sees in the history of science. He makes the point in *Ideology and Rationality in the History of the Life Sciences* that viewing history as the discourse of memory and epistemology as the discourse of judgment sets up a dichotomy that makes history nothing more than the catalog of who did what, when, and why. Such a revue of events is irrelevant because "one turns to the 'past' as required by present needs in search of more or less remote antecedents to some present state of affairs" (Canguilhem 3). History, according to Canguilhem, has explanatory power because "alteration" is fundamental to the historian's task. History actually changes when revolutionary

new "discoveries" are made, but it is "not simply a matter of rewriting" the rehearsal of antecedents to account for the new object (Canguilhem 17). Epistemological breaks within a particular science change the history of that science even while "linguistic habit leaves its name unchanged" (Canguilhem 16).

As Kuhn also pointed out, textbooks, popularizations, and the philosophy of science all "record the stable outcome of past revolutions and thus display the bases of the current normal-scientific tradition" (Kuhn 137). This description of the history of science, where the "winning paradigm" determines what will be included in the story of its development, engages in what Canguilhem called the "banishment of inauthentic knowledge from the realm of authentic science" (27). While Kuhn views science as progress away from the "primitive," Canguilhem points out that "what is at stake [in writing the history of science] is nothing less than the legal withdrawal of legitimately acquired privileges" (27). To understand the history of any science, we need to avoid this banishment and recognize our role in constructing truth.

In *Reflections on Gender and Science* Evelyn Fox Keller presents an interesting example of Canguilhem's use of the term "banishment" in reference to the delegitimation of a science. In her examination of the birth of modern science, Keller shows how adherents to Descartes's mechanical philosophies of science delegitimized hermetic philosophies of science in large part by invoking images of alchemists cavorting with witches. She examines the language of Joseph Glanville's accusations, among others, to show how mechanistic knowledge comes to represent the proper domain of knowledge, but only as an authentic knowledge that can be subverted by "the Woman in us" who seduces the scientist into "recondite

knowledge" that is ungodly and Satanic (59). Keller argues that the "alchemists appeared threatening not only because of their religious and political radicalism, . . . but also because of their commitment to a science steeped in erotic sexual imagery and, . . . to the symbolic equality of women before God" (59). As Keller illustrates, modern science developed through ideological metaphors that equated masculinity with mind, reason, objectivity, and autonomy and femininity with body, emotion, subjectivity, and dependence. Hence we cannot write the history of science without examining the "role played by metaphors of gender in the formation of the particular set of values, aims, and goals embodied in the scientific enterprise" (Keller 43).

Richard Lewontin makes a similar point regarding the notion that nucleic DNA is the "blueprint" for life. He argues that this view of nucleic DNA as primary actant and the "merely mechanical, secondary role of the cell machinery that uses that blueprint for production is another form of the deep cultural prejudice (characteristic of modern capitalism) that mental labor is superior to mere physical labor, a prejudice that is replicated in the entire structure of laboratory life" (1264). Gender is also a component of this prejudice as the "cell machinery" is inherited maternally via mitochondrial DNA.

Kuhn explicitly acknowledges the need for such studies to understand the development of a particular science, but he does not seem to feel that they are central to the macrocosmic structure of scientific progress. Still, Keller's examples illustrate that it is not always the ability to address anomalous data that makes one scientific paradigm victorious over another. Rather, scientific debates occur as part of a cultural context and not in some separate and neutral space, and because they

are important players in these wider cultural debates, these cultural conflicts can shape paradigm conflicts within a science.

Scientific Ideology and the (Re)Definition of Knowledge

According to Canguilhem, Marx defined ideology as any discourse that claims to be about reality but is "in reality" a method of "protecting and defending . . . a particular structure of the relations between men and things" (29). Ideologies are illusory because they are inaccurate depictions of the real that comfort us like "reassuring fables, unconsciously complicit in a judgment determined by self-interest" (Canguilhem 31). Marx did not view science as an ideology, although he did argue that "the science of nature is not independent of the mode of production and exploitation of nature" (Canguilhem 31). His attraction to science comes from the view that science becomes authentic only "by tearing the veil that is ideology's only substance" (Canguilhem 30).

Canguilhem shares this view of authentic science. He makes a distinction between scientific ideologies such as atomism, heredity, and evolutionism and the sciences that displaced them. For Canguilhem scientific ideology, unlike other ideologies, "is not false consciousness" because it makes "explicit [its] ambition to be science" according to an "already constituted model of what science is" (32-3). Because scientific ideologies aspire to be science and yet neglect "the methodological requirements and operational possibilities of science," they mark off a site for the production of knowledge that will "eventually be occupied by science" (Canguilhem 33).

Canguilhem's scientific ideologies seem to serve the same purpose in the historical development of science as Kuhn's paradigms. According to Canguilhem,

however, science never finds "what ideology suggested looking for" (34). It is not simply a matter of solving the puzzles raised within a particular scientific ideology or "paradigm." When science takes over the site formerly controlled by a scientific ideology, it does not simply supplant it. The truth claims of the scientific ideology are called into question by the truth claims "obtained through systematic research" in a particular science (Canguilhem 34). This does not mean, however, that scientific ideologies are not a type of knowledge. They too generate knowledge by making systematic research possible.

Canguilhem argues that even with the advent of a classless society, where Marx argued ideology's delusionary function would no longer exist, there would be the question of "man's relation to nature," which would call for the use of scientific ideologies (32). Although Canguilhem places science outside of scientific ideology, he wants to avoid banishing the latter as pseudoscience because to do so would imply that science could exist without it. Scientific ideology is "both an obstruction to and a necessary precondition of progress" in the acquisition of knowledge (Canguilhem 32). Therefore, what we need to include in any history of science, according to Canguilhem, is "a history of scientific ideologies, explicitly recognized as such" (32). By examining the development of science in this way we come to a better understanding of both science and history. As Canguilhem argues, if we make absolute distinctions between ideology and science that "banish" the former from the realm of legitimized knowledge, we will fail to see "elements of ideology preserved in a science that has supplanted an earlier ideology" (39).

For Canguilhem, "the historian cannot accurately see any object that he does not actively construct. Ideology is mistaken belief in being close to truth. Critical

knowledge knows that it stands at a distance from an operationally constructed object" (39-40). If the historian of science fails to examine scientific ideology, s/he "runs the risk of producing nothing more than ideology" in the sense of a "false consciousness" (Canguilhem 39). This ideology would reinforce the truth claims of science in a way that legitimizes the application of scientific knowledge to social structures beyond the situated and therefore contingent context of that scientific knowledge.

Canguilhem regards Kuhn's notions of "normal science" and "paradigm shift" as impotent because they are "simple cultural facts" incapable of a real "break with established rules and procedures." Moreover, Canguilhem argues that critical knowledge of the truth effects produced by scientific ideology can be used to hold ideology at bay and study its interaction with authentic science. For Canguilhem, writing the history of science "is really an epistemological problem concerning the way in which scientific knowledge is historically constituted" (28). For Kuhn, writing the history of science means examining paradigmatic shifts in the kinds of questions science asks about the objects it decides to study, but it is not so much a matter of examining the nature of scientific knowledge. And yet, Canguilhem is aware that his approach to the history of science also engages in an unveiling operation that "mimics" the "practice of scientists by attempting to reconstitute the means by which knowledge is produced" via the historian's study of scientific discourse (8).

Jean-François Lyotard's examination of what constitutes knowledge in *The Postmodern Condition* provides a valuable analysis of the legitimation of scientific and other ideological discourses and calls into question the disciplinary boundaries

that divide our concept of knowledge. Lyotard argues that while "scientific" discourse seems to "speak the truth about the referent" in a statement that can be verified by others, scientific knowledge is "indirectly a component of [narrative knowledge] because it develops into a profession and gives rise to institutions" (24-5). He argues that scientific knowledge, like all knowledge, "is a question of competence that goes beyond the simple determination and application of the criterion of truth" (18). The formation of "good" denotative, prescriptive, and evaluative statements is judged according to their conformity with "the relevant criteria . . . accepted in the social circle of the legitimating interlocutors" (Lyotard 19). Hence, scientific knowledge is judged via the institutional constraints which "function to filter discursive potentials . . . [and] privilege certain classes of statements" (Lyotard 17). Scientific knowledge tries to set itself "apart from the language games" of "narrative" discourse by allowing only one type of linguistic move, the denotative statement (Lyotard 25). Lyotard argues that while scientific knowledge "has always existed in addition to, and in competition and conflict with . . . narrative," it has relied on philosophical discourse to legitimate its own project (7).

The conflict between the two types of discourse strategies is unequal. As Lyotard argues, while narrative discourse "approaches [scientific discourse] primarily as a variant in the family of narrative cultures, . . . the scientist questions the validity of narrative statements and concludes that they are never subject to argumentation or proof" (27). The validation that scientists see as proof within their own discourse is based in a logical positivism that considers narrative types of knowledge less rigorous, "primitive," and merely matters of custom. While

Canguilhem argues that a constructivist history of science mimics scientific activity in its study of scientific discourse, Lyotard argues that scientific discourse is ultimately based in narrative discourse and cannot claim to be the one best method for knowledge acquisition. Lyotard argues that it is the reliance on consensus that makes science dependent on the narrative of philosophy for its legitimation. Science assumes that while "not every consensus is a sign of truth; . . . the truth of a statement necessarily draws a consensus" (Lyotard 24). In order to verify the truth of scientific statements, scientists need a set of interlocutors who are their equals, and "didactics is what ensures" the production of scientists (Lyotard 24). Instruction in the sciences, as both Kuhn and Lyotard point out, is based in a history of science that makes it an epic hero in the search for knowledge of the real.

Lyotard examines how this epic tale has also made science one of the state's legitimizing institutions. He points out that the "state spends large amounts of money to enable science to pass itself off as an epic: the State's own credibility is based on that epic, which it uses to obtain the public consent its decision makers need" (28). He examines how the world has been viewed as either "a self-regulating system" where system stability is the goal of those in power and dysfunction or innovation is viewed as "only an internal readjustment" that will improve the system, or as a divided world where the struggle between interested parties makes them "wary of syntheses and reconciliations" (12). It often seems that we must choose "between functional and critical knowledge," and we are tempted to avoid deciding by separating knowledge into the positivist kind, which "would be directly applicable to technologies bearing on men and materials," and the "critical, reflexive,

or hermeneutic kind," which would reflect "directly or indirectly on values or aims, [and] would resist any . . . 'recuperation'" (Lyotard 14).

While it might seem that Canguilhem engages in such a partitioning of knowledge, with science as the former and critical histories of science as the latter, his recognition that both discourses engage in denotative unveilings that are at the same time also part of narrative representations complicates such a reading. For Lyotard any such separation is an unacceptable partitioning of knowledge because it is "caught within a type of oppositional thinking that is out of step with the most vital modes of postmodern knowledge" (14). Both discourses are, according to Lyotard, Wittgensteinian language games where the rules of the game "are the object of a contract . . . between players" (10). When viewed in this way, all discourse is a "playful" fight over the rules that will govern the social bond. All social institutions place limits on linguistic moves, but these limits "are never established once and for all. . . . the limits are themselves the stakes and provisional results of language strategies" (Lyotard 17). So the potential for strategic language moves or a change in the rules governing the contract between players offers opportunities for the delegitimation of existing power structures.

And yet, while "not even the least privileged among us is ever entirely powerless over the messages that traverse and position him at the post of sender, addressee, or referent" (Lyotard 15), science and technology are games that require money to produce proof and the "games of scientific language become the games of the rich" (Lyotard 45). Laboratories require large investments in technical equipment, but they also "optimize the efficiency" of scientific experiments and thereby increase the value of that investment (Lyotard 45). The validation

requirements of science can increase the value of invested capital by providing those in power with discourses that increase their credibility and naturalize their power.

In post industrial societies, knowledge is also being turned into information with commodity value instead of use value, and multinational corporations are becoming the locus of investment and decision making in control of vast quantities of commodified information. This is clearly an area of debate in the Human Genome Project as Celera Genomics's success forces the public consortium to publish their sequence in draft form in *Nature* and *Science* publishes Celera's sequence while allowing proprietary restrictions on use of the data. The rules governing scientific publishing are being challenged by corporate involvement in genetic research. Lyotard argues that with the increasing "mercantilization of knowledge" its goal has moved from examining questions of truth to questions of function, exchange value, and efficiency (51). The ruling class of "corporate leaders, high-level administrators, and the heads of the major professional, labor, political, and religious organizations" control the decision making process because they have access to such information and use it to encourage system stability (Lyotard 14).

And yet, Lyotard sees scientific discourse as an "open system" that provides an opportunity for resistance to those who try to control the language moves of both scientific and legal discourse "according to input/output matrices" in order to increase their power (xxiv). Lyotard argues that postmodern science works by looking for "the unintelligible" and generates a type of knowledge that produces "the unknown. . . . [and] suggests a model of legitimation that has nothing to do with maximized performance, but has as its basis difference understood as paralogy" (60). In response to the demand for legitimate knowledge, postmodern

science has focused on "such things as undecidables, the limits of precise control, conflicts characterized by incomplete information, 'fracta,' catastrophes, and pragmatic paradoxes" (Lyotard 60). For Lyotard, postmodern science and philosophy are "changing the meaning of the word knowledge" through the recognition that knowledge is created only through the linguistic forms we use to structure our experience (60). Still, there is plenty of old fashioned positivist science still being done that has tremendous influence on human social structures.

For Lyotard, scientific discourse never fully achieves consensus because scientific progress only occurs through statements that say something different than what has been said before. This makes science "an antimodel of a stable system" (64). As such, science may be put in the service of hegemonic forces, but science is not inherently hegemonic. Lyotard argues that we need to view science as one of the many "heteromorphous" language games where "any consensus on the rules defining a game and the 'moves' playable within it must be . . . agreed on by its present players and subject to eventual cancellation" (66). Lyotard's vision of the social bond generates an image of social interactions based on temporary contracts instead of institutional hegemony. While this can be liberatory, it can also further centralize power, since science is an expensive language game that not everyone can afford to play. Likewise, Lyotard feels that the increasing computerization of knowledge could either assist the managerial class in their struggle to control social structures or, if made publicly available, help keep the language games moving to avoid hegemony. Lyotard's optimism seems somewhat naive here since, as he points out, the cards are stacked on the side of hegemony. While access to information and individual contractual social and business relations might make

resistance possible for some, it seems unlikely that it would prove beneficial for most.

Narrative and Scientific Discourse: Representing to Intervene

Many feminist theorists have examined how specific scientific discourses have engaged in naturalizing gendered power relationships through the common twin images of science as a masculine yet disembodied objectivity and nature as a feminine object of study. As Evelyn Fox Keller argues in *Secrets of Life, Secrets of Death*, "language simultaneously reflects and guides the development of scientific models and methods," so it is important to examine how it does so (6). Even though scientific theories cannot "hope for a one-to-one correspondence with the real," the fact that they "represent in order to intervene" requires that they "possess a kind of 'adequacy' in relation to a world that is not itself constituted symbolically" (Keller 73-4).

This effectivity does not require that the theory be true or just, only that it provide us with "instrumental knowledge [that] has force in the world" (Keller 74). Keller turns to physics to identify force as "a vector" and thereby claim that it always has directionality (75). Both Keller and Lyotard argue that this demand for effectiveness or "performativity" in a method of manipulating the material world provides only for the creation of power, not the performance of justice or the revelation of truth. While Lyotard seems to expect the postmodern redefinition of knowledge to re-shape all science, Keller argues that the failure to focus simultaneously on both the truth claims and the consequences of science resists such a reshaping. Her work examines how ideology shapes scientific theories and research in the hope that such analyses will help us understand "how particular

representations are already committed to particular kinds of interventions" (76). By understanding this "enmeshing of representation and intervening," Keller hopes that we can re-shape the direction of science in ways that make it a more liberatory discourse (76).

Much of Donna Haraway's work in *Simians, Cyborgs, and Women* engages in the same kind of historical analysis as Keller's and Canguilhem's. She too is interested in reshaping the direction of science through a more liberatory concept of knowledge based on a notion of situated objectivity. In "A Manifesto for Cyborgs" Haraway invokes the utopian image of the cyborg as a representation of postmodern embodiment. Through the metaphor of the cyborg body, Haraway advocates a politics based "in claims about fundamental changes in the nature of class, race, and gender in an emerging system of world order analogous in its novelty and scope to that created by industrial capitalism" (161).

Like Lyotard, Haraway argues that "we are living through a movement from an organic, industrial society to a polymorphous, information system" (161). Haraway illustrates how the "old hierarchical dominations" are being translated into "the scary new networks" she calls "the informatics of domination" (161), and argues that in the post industrial world all "objects that can be known scientifically must be formulated as problems in communications engineering (for the managers) or theories of the text (for those who would resist)" (162-3). Both are "cyborg semiologies" in that both are potential language moves in this brave new post industrial world (Haraway 163).

Haraway has continued to develop the metaphor of the cyborg as a representation of postmodern embodiment in her later work, *Modest_Witness@*

Second_Millennium. FemaleMan©_Meets_OncoMouse™. For Haraway, the cyborg represents bodies that cross boundaries, bodies that are at once one thing and its other, bodies that undermine categories of identity. Cyborgs are organic and technological, conscious and unconscious, natural and artificial, self-developing and externally designed. It is this hybrid nature of the cyborg that Haraway appeals to as a resource in her struggle for a new method of political action based on networks of affinity rather than identity and recognition of the situated and partial nature of all knowledges. Haraway argues that the cyborg is particularly appropriate as an image of postmodern embodiment because it is a byproduct of the military industrial complex and post-Fordist capitalism. As such it has no myth of original purity and subsequent degradation from which it can hope to recover. This is important for Haraway's purposes, particularly in the "Manifesto," because destabilizing the Western nature/culture dichotomy and its apocalyptic teleology is central to her project.

In both the "Manifesto" and *Modest_Witness*, Haraway refers to the texts of biologist Richard Dawkins as work that has radically denaturalized the concepts of the individual and the organism by making them "ontologically contingent constructs" (220). Dawkins redefines the individual life form whose survival is ultimately at stake as the gene, which makes bodies "strategic assemblages" of genes interested in their own survival and replication (qtd. in Haraway 220). Haraway is attracted to this work because it reflects the organizational strategy she is advocating, but as she also points out, Dawkins's portrait of postmodern embodiment is "one that leads to theorizing the living world as one vast arms race" (217). His reinscription of the evolutionist notion that life is fundamentally selfish

instead of cooperative in the "struggle for survival" is not the best model for the "situated knowledges" and "cooperative networks" that Haraway advocates.

In the "Manifesto," Haraway also refers to the Human Genome Project as a "a kind of technology of postmodern humanism, defining 'the' genome by reading and writing it" (215). The project began in 1988 as a multi-billion dollar effort to generate genetic, physical, and nucleotide sequence maps of a composite human genome, as well as the genomes of other life forms commonly used in lab experiments, such as mice and yeast. It is, in fact, as Richard Lewontin has pointed out, more accurately described as an administrative and financial organization through which public money is channeled into a variety of research programs and "Genome Centers" at large laboratories than as a specific research program of its own. It is also a textbook example of what David Harvey identifies in *The Condition of Postmodernity* as the shift to flexible accumulation strategies and increasing technological dynamism that is typical of late capitalism. The Human Genome Project, in combination with changes in tax and patent laws in the early 1980's, was designed to encourage research agreements among biotechnology companies, universities, and non-profit organizations.

One interesting example is the non-profit organization called The Institute for Genomic Research (TIGR). It was founded by Human Genome Sciences, Inc. (HGS) as a nonprofit partner, and both TIGR and HGS were initially funded with $125 million from SmithKline Beecham in return for the first option on any patentable materials or products that might be generated in their labs (Marshall 1800-1). HGS, TIGR, and SmithKline Beecham also agreed to open their new database of gene sequences, the largest in the world at that time, to other nonprofit

researchers, provided they sign a contract that leaves all options for commercial development with HGS, and thereby with SmithKline Beecham. Over 100 nonprofit researchers had signed the agreement in order to gain access to this database within a year (Marshall 1802). By opening the database but retaining proprietary control of its value, SmithKline has the opportunity to benefit from the work of academic researchers around the world, while the cost of their employment remains with public institutions.

Such a method of "outsourcing" expensive research and development activities is typical of the flexible accumulation strategies of late capitalism that Harvey describes. It is indeed a "cyborg" discourse, but one where tremendous pressures are mapping our cyborg boundaries into what Haraway has called the "informatics of domination." The genome's status as a "postmodern" artifact that produces bodies through a chemical language cannot, as Haraway is well aware, keep it from being incorporated into the teleology of evolutionary progress, and its correlative, the genetic marketplace. It is the role of Haraway's modest witness to resist such pressures by engaging the "informatics of domination" in the battle over cyborg boundaries. This dissertation likewise hopes to bear witness to the corporealization of DNA in an effort to join the battle over cyborg boundaries.

In order to more fully understand the processes of knowledge production in genomic technoscience, it is important to examine how a "metaphysics of presence" is often operating within discourse on the genome. In *Secrets of Life / Secrets of Death: Essays on Language, Gender and Science*, Evelyn Fox Keller examines how the evolutionist's struggle to understand patterns of inheritance has elided the problem of sexual difference and been based in sociopolitical notions of the

individual. She illustrates that it is common for population biologists to use language and equations that mask the role of gene exchange in meiosis. Keller argues that this language, far from being accidental, "provides crucial conceptual support for what might be called the central project of evolutionary theory . . . [which] remains the location of the causal efficacy of evolutionary change in heritable properties of individual organisms" (129).

Moreover, Keller argues that slippage between the colloquial and technical meanings of various terms, including the notion of the individual, weaves "sociopolitical assumptions" into science. These assumptions are based in a notion of the individual as self-present entity and generate particular value laden notions of internal and external dynamics regardless of what one posits as the unit of selection. Keller identifies two sets of values in discourse on the genome: In the first are "autonomy, competition, simplicity; a theoretical privileging of chance and random interactions, and the interchangeability . . . of units," and in the second are "interdependence, cooperation, complexity; the theoretical privileging of purposive and functional dynamics, and often a hierarchical organization" (145). Keller calls these two sets of values "public" and "private" because the organizational dynamics between individual units of selection are thought of as fractured and competitive, while organizational dynamics within a unit of selection are thought of as coherent and self-serving.

Recent struggles over the definition of the unit of selection are a consequence of viewing natural selection as the selection of an individual self-identical unit, whether that unit is the group, the organism, or the gene as "trait." For Keller there can be no single unit or individual on which natural selection acts. She argues that in

order to fully account for sexual difference in any evolutionary narrative, natural selection must be said to act on the gene, the organism, and the species simultaneously. From this perspective, "fitness" becomes a property of the system of difference generated among genes, organisms, groups, and their environments rather than a property of a single, essential unit of selection.

The "metaphysics of presence" is also, and not coincidentally, the basis of our legal definitions of authorship and copyright. As Mark Rose argues in *Authors and Owners*, "copyright is founded on the concept of the unique individual who creates something original and is entitled to reap a profit from those labors" (qtd. in Haraway 71). Haraway summarizes Rose's argument as follows:

> The many actors involved in making a literary text gave place to the inspired author of a work. Literature was commodified in new and socially powerful ways that reached to the heart of what would count as a person and a person's products. Rose argues that the discourse of original genius was rare in England in 1710 but orthodox by 1770; in parallel, authors' rights in their literary works were first established in the Statute of Anne in 1710. . . . The representation of the author as proprietor of the work and of the self rested on the Lockean idea of property. . . . [In 1690 Locke had] argued that man has property in his person and that he mixes his labor with nature to make other property. (72)

As Haraway points out, this notion of property in the self was used to draw "the key distinctions between public and private" (72). Moreover, she says that "property is the kind of relationality that poses as the-thing-in-itself, the commodity, the thing outside relationship, the thing that can be exhausted, measured, mapped, owned, appropriated, disposed" (8).

It is this understanding of property in the self that reframes Haraway's analysis of Richard Dawkins's notion of the "selfish gene." Whereas in *A Manifesto for Cyborgs* Haraway embraced Dawkins's shift to the "gene's eye view" for its rejection of any notion of organic unity on the level of the organism, in *Modest_Witness@Second_ Millennium* Haraway is critical of his use of the gene as the coherent unit of selection. Haraway now argues that Dawkins is a gene fetishist; saying that, "In [Dawkins's] view, genes are things-in-themselves, outside the lively economies of troping. [But] to be outside the economy of troping is to be outside finitude, morality, and difference, to be in the realm of pure being, to be One, where the word is itself" (134). Recognizing how the notion of property structures concepts of the unit of selection, and hence all evolutionary tales, has made Haraway more critical of Dawkins's views.

Haraway does not, however, believe that the Human Genome Project's mapping effort is a fetishization of the genome. She distinguishes between commodity fetishism, where "things are mistakenly perceived as the generators of value, while people appear as and even become ungenerative things," and map fetishism, which reifies particular narrative spatializations into what seems a non-tropic representation (135). As Haraway argues, these kinds of maps would seem to occupy "the space of clarity and uncontaminated referentiality, the kingdom of rationality. That kind of clarity and that kind of referentiality are god tricks" (136). But for Haraway, the Human Genome Project's mapping activities are a type of "corporealization," which "is not reducible to capitalization or commodification," but is "tropic and historically specific at every layer of its tissues" (141-2).

Haraway argues that "technoscientific bodies, such as the biomedical organism, are the nodes that congeal from interactions where all the actors are not human" (142).

With the inclusion of "non-human actors" in her notion of corporealization, Haraway generates a more pragmatic constructivist system of technoscientific knowledge production. By bringing the "body" into the realm of constructed objects as one of the *actors* in knowledge formation, Haraway avoids mere relativism. She argues that while a "gene is not a thing, much less a 'master molecule' or a self-contained code," it is part of "a node of durable action" where both the human and the nonhuman interact to generate meaning (142). Corporealization is not, therefore, inherently part of the "culture of no culture and the nature of no nature," but "fetishism is a common syndrome in technoscientific practice," and Haraway's modest witness needs to resist this temptation in order to generate powerful situated knowledge (143). This position is similar to that of the science historian for Canguilhem in that both are expected to generate criticism that works to separate ideological fetishisms from the work of scientific corporealization. Haraway's modest witness and her vision of scientific activity as a corporealization, however, do not have to rely on the notion of an "authentic" science that critical knowledge could help create by examining the interaction of scientific ideology and science proper.

Science Warriors and Sophists

Such arguments have generated often heated resistance to constructivist analysis of scientific activity, emerging most visibly in the so-called "science wars" of the last decade. Bruno Latour tries to offer us a potential resolution to this conflict over the meaning of scientific truths in *Pandora's Hope: Essays on the*

Reality of Science Studies. Latour un-declares the war by developing theories of translation and articulation to replace the dueling notions of science as pure discovery or pure construction. He opens *Pandora's Hope* with a question asked by a friend who is also a scientist: "Do you believe in reality?" (1). After registering his surprise at the seriousness with which this question is asked, he examines how the current relationship between science and technology studies (STS) scholars and scientists makes this question both possible and important.

For Latour, reality becomes an object of belief only for those who have accepted the "cascade of settlements" required when one posits humans as "minds-in-vats." He argues that epistemology headed down the wrong path when it began positing the human mind as a site of disembodied cogitation that could, nevertheless, produce real knowledge of the world. Latour argues that from Descartes's bodiless cogitation, through the "catastrophe" of the Kantian *a priori*, to the paradigms of a given social group, epistemologists have sought ways to maintain a connection to the real world while developing a site capable of universal knowledge (4-6). We have long desired the God's eye view, yet we've also always known that all convincing claims to knowledge must be grounded in embodiment somewhere along the line. The sleight of hand Latour acknowledges is one that removes the person claiming to have knowledge from the scene of knowledge production, creating a ventriloquism of eternal Nature whose only real use is in the control it offers over others. To get the power inherent in divine perspective, we've come to think of ourselves as disembodied in order that we might "know" our others, who remain, of course, thoroughly embodied themselves.

Latour recognizes that the twin fears inherent in his friend's question about belief in "reality" are the fear of loosing access to the universalized truth of scientific analysis and the fear of mob rule scientists often see in constructivist arguments about the meaning and source of scientific truths. For Latour, their fears are misplaced. Through his analysis of Plato's *Georgias*, Latour generates an origin story for the connection between this fear and all appeals to the abiding truths provided by scientific method. In Latour's reading of the *Georgias*, it is the fear of mob rule that motivates this founding moment in the long history of science's claims to universal knowledge.

Western philosophy has typically understood Socrates's arguments with the sophists as a battle between the might of mob rule and the right of universal scientific and moral truths. Latour's analysis turns this interpretation on its head by pointing out that the real argument between Socrates and Callicles is over how best to control the potential for mob rule unleashed by a democratic government. Plato's Socrates invokes a spirit of abstract cogitation with access to a truth guaranteed by its location beyond the veil of death precisely because he feels it is necessary to have access to a universalized knowledge in order to control the unruly mob in the agora. What is really going on in the *Georgias*, according to Latour, is an argument between might as aristocratic sophist manipulation and might as higher truth (a disguised aristocratic manipulation that is much harder to resist because its claims become reified as truths) (216-35). Latour calls Socrates "one of the first of many in the long history of mad scientists" who hopes to "rule over the citizens of the city even [from] beyond death" (12). Yet for Latour, there is an important

difference between science conceived as the discovery of eternal truths about Nature and what really goes on in scientific research.

The title for Latour's analysis of the *Georgias*, "The Invention of the Science Wars," illustrates the connection he sees between Socrates's claimed access to a universal knowledge guaranteed by its location in a world of spirits beyond the influences of those in the unruly agora and the recent battles over the nature of scientific truth. In order to end current conflicts, open science to democracy, and rediscover the hope Pandora left in the bottom of the black box, Latour suggests listening to what STS scholars have to say about how science engages reality. When STS first began, it examined scientific practice, and thereby generated more accurate analysis of scientific activity than the romantic heroism generally offered in biographies of discovery. STS scholars found that facts are indeed fabricated, but Latour argues they also found reality when they began speaking of human and nonhuman actants rather than objects and objectivity. For Latour, the importance of using the terms "human and nonhuman actants" rather than subjects and the objects they study is that it acknowledges the agency of things as well as the role of the material world in the formation of humanity.

He tells those scientists doing battle in the "Science Wars" to "calm down" because being "part of a collective will not deprive you of the nonhumans you socialize so well. It will only deprive you of the polemical kind of objectivity that has no other use than as a weapon for waging a political war *against* politics" (20). In other words, believing that science provides accurate knowledge about a stable and knowable natural world allows one to argue that scientific activity occurs separate from cultural activity and has no effect but the revelation of truths which

must simply be accepted, but this belief is illusory. There is a certain naivete in Latour's claim that scientists will be able to go about business as usual if scientific activity is opened up to the agora. As Lyotard, Canguilhem, and Haraway all point out, scientific activity is generally expensive and its priorities and methods have been shaped by the interests of those with the capital to invest. Increasing the general public's role in shaping scientific activity, while a laudible goal that I share with Latour, will not leave scientists unaffected. Some will no doubt find their funding cut or applications of their research restricted, but others will find increased support.

For Latour, the reality one finds when examining scientific activity is that of a collective of humans and nonhumans whose actions and interactions generate our selves, our world, our knowledge of both, as well as the things themselves. Unfortunately, there is a certain slippage into the essential in Latour's language, or, alternatively, a certain elision of the textual and performative nature of such "Being" that he finds difficult to avoid precisely because he fears slipping into a postmodern "hell" without agency or knowledge. He does argue that scientists do not discover preexisting natural objects by observation, rather they generate technologies that set the stage for nonhuman actants to perform actions that are then socialized into the collective of humans and nonhumans. What Latour does not always seem to acknowledge is that it is the nonhuman actant's staged performances that are socialized into the collective, along with human performances. It is not the nonhumans as essential selves, nor even the humans as essential selves, but rather the event of their interactive performed being-in-the-world that generates what we call knowledge and what socializes new "being(s)" into the collective. This

interactive performance gives us a situated knowledge, one that is itself a performance, rather than a universalized knowledge, regardless of what our knowledge-performances claim. Latour does argue that to view Nature as eternal and therefore simply discoverable is to deny the historicity of things, as well as our own historicity, and that we are all changed by our activities and interactions in the unfolding of both scientific and cultural activity.

According to Latour, what science studies adds to knowledge is the reconnection of science with culture by recognizing its historicity, and it is this reconnection that will make science both more capable and more humane, and the humanities less tied to the notions of organic wholeness that Donna Haraway so roundly and rightly criticizes. Yet it can only do so if the general public is empowered to help shape scientific priorities, activities, and applications. Latour's text is dedicated to, among others, Donna Haraway, and it seems many of his current views are heavily influenced by her work. In his struggle to account for what he has observed scientists doing in practice, although he would hate to admit it, he has had to move closer and closer to some of those postmodernists for whose work he "could not [find] words ugly enough" in *We Have Never Been Modern* (61).

Indeed, while there is much to be praised in Latour's effort at concluding the "Science Wars" by encouraging the move from science (conceived as the search for facts about an eternal Natural world) to research (conceived as the effort to interact with and incorporate the nonhuman world into human activities in increasingly complex ways), it is difficult to wade through the insults he flings carelessly about at those whose work has so much in common with his own. The unacknowledged

irony of his final chapters on the violence of the iconoclast smashing idols and his own violent rhetorical gestures against everyone from those who want to hold on to notions of pure science to those who have undermined such notions at every turn is so obvious that one is amazed he does not see it himself.

Perhaps this violence stems from Latour's frustration with trying to negotiate a definition of knowledge that retains some claim on reality while at the same time acknowledging the constructed nature of knowledge. It seems he finds himself facing the same problem Thomas Kuhn faced in that he wants access to a scientific knowledge that retains a traceable connection to the real while at the same time acknowledging that all knowledge is constructed. To better understand the difficulties Latour faces in his struggle to generate a constructivist account of the knowledge science produces, I will examine how his notion of circulating reference is developed. While it may initially seem to operate like the Derridian description of the citationality of language, his periodic refusal to acknowledge the abyssal gaps that make citational movements possible indicate the kind of challenge faced by all attempts at generating a realist constructivism. The notion of a distributed agency that does not require conscious intent to count as agency is a promising way of answering this challenge.

Circulating Reference, Articulations, Historicity

In *Pandora's Hope,* Latour relates his observations from a field expedition designed to study changes in soil composition and foliage on the edge of the Amazon forest to argue that scientific research produces knowledge of reality via a process of circulating reference. He views his opportunity to accompany scientists on this expedition as "a chance to study empirically the epistemological question of

scientific reference" (26). His explicit goal in going on this field expedition is to examine "how the sciences can be at the same time realist and constructivist, immediate and intermediary, reliable and fragile, near and far" (30). Moreover, he wants to show "that there is neither correspondence, nor gaps, nor even two distinct ontological domains, but an entirely different phenomenon: circulating reference" (24).

While this essay is written well after the expedition, he reports his findings as if they are written during a process of discovery, thus rhetorically eliding the constructedness of his own text. Hence, he reports early in the piece that laboratories are less viable as locations for studying the original moments of scientific truth making "in direct confrontation with the world" and that field work will give him a better vantage point from which to view science-in-the-making (30). This is, however, a "realist" literary conceit on his part as he knows full well at the time of writing the piece that the area of Amazon forest under study has already been transformed into a laboratory, having been mapped and marked using older technologies of knowledge.

After remarking on the numbered tags on the trees in this "minimalist" laboratory, Latour says: "I rediscover the tautology that I believed I was escaping by coming into the field. One science always hides another" (32). It would be more accurate to say that one technology of knowledge always hides another, and that languages themselves are such technologies of knowledge. Latour has used that technology here to present a narrative of discovery that makes his argument more convincing precisely because it makes it seem more connected to direct observation,

more empirical, more "realistic" than the discourse of philosophy that he sets up as his foil.

What Latour finds on this expedition into the non-original origin of science is that scientific "mastery" only occurs through technologies of inscription. What these technologies allow is the perspective of a "unifying gaze" made possible by the ability to select and "shift the position of specimens and substitute one for another as if shuffling cards" in order to "discern emerging patterns" (Latour 38). In "mastering" the world through technologies of inscription, the scientist both chooses and shuffles the specimen "cards" in order to *create* a gaze that unifies. Latour argues that this unifying gaze is necessary to discern patterns, that we must be blind to some details in order to see on a more generalized level, that we must ignore in order to know. Latour states: "In a beautiful contradiction, the English word 'oversight' exactly captures the two meanings of this domination by sight, since it means at once looking at something from above and ignoring it" (38). What is occurring when Latour's scientists discern a pattern among the collected, organized, and cataloged specimens is a translation of part of the Amazon forest into scientific discourse. According to Latour, "in losing the forest, we gain knowledge of it" (38).

This is, of course, the paradox of all acts of translation, whether from Swahili into French or soil into pedology. All translators must ignore some layers of meaning in order to bring into their language at least some of the otherness of the text being translated. There are, however, important slips in Latour's language in that he sometimes claims the entire forest is known through this metonymic operation of sampling. At others, he acknowledges that in losing the forest, we gain

a limited knowledge of only that part of it we have chosen to translate. Interestingly, Latour compares this process to political representation:

> Only the few specimens and representatives that are of interest to the botanist have made it into the collection. So are we, therefore, far from the forest? Let us say we are in between, possessing all of it through these delegates, as if Congress held the entire United States; a very economical metonymy in science as in politics, by which a tiny part allows the grasping of the immense whole. (36)

During this representation, delegation, transportation, translation, Latour argues that "something has been preserved," and it is this preservation of some "*je ne sais quoi*" that makes scientific reference speak in some way about the real (36). Of course, not everyone is represented by the officials chosen in the democratic process, nor is the whole of the Amazon contained in the pedologists' report on patterns in soil transition.

Total truth, total representation, total translation is impossible, nor are they necessary as we have really always used our technologies of inscription and the approximate translations of the world that they produce to negotiate the relationships among humans and non-humans, and we can continue to do so even when we finally give up the fiction of mastery. Of course, this is one of Latour's major points in *Pandora's Hope*, and yet it is difficult to maintain such a position while simultaneously defending science's ability to speak truthfully about a physical reality that it engages. The problem of using a discourse that speaks of "truthfullness" instead of "efficacy" is illustrated by Latour's slippages.

Our knowledge is limited not only because it cannot be comprehensive, but also because we can only see according to the codes embedded within our

technologies of inscription, which mark the limits of understanding in the language into which we are translating. These codes do not remain as static barriers to understanding, however, since languages and the codes behind all technologies of inscription are changed through such acts of translation. Ultimately, that "*je ne sais quoi*" will become the truth effects produced by the continual activity of the technologies of inscription that produce knowledge, and we will find ourselves playing Lyotard's language games despite Latour's resistance. The only way knowledge, like political power, can be thought of as comprehensive is through a "grasping" of the "immense whole" made possible by the discursive performance of a "representative" few, but this grab for total knowledge is, as Latour himself argued in his analysis of the *Georgias*, nothing more than the grasping of power over others, both human and nonhuman.

For Latour the question of how science generates knowledge comes down to a simple chain of inscriptions and depends upon how one answers the following question: "Is the referent what I point to with my finger outside of discourse, or is it what I bring back inside discourse?" (32). Of course, pointing itself could be viewed as a technology of inscription, a rudimentary sign language that helps the pointer translate the physical world into the discursive. This view does not make pointing originary, however, since pointing requires at least two prior systems of difference (one physical or discursive and one discursive) for the act to have any meaning. The gesture refers not only to the example, but to others like it and to its agreed upon representatives within a particular linguistic system.

Latour argues that, for science as for criticism, reference is not, however, simply a question of retaining evidence (in the form of specimens and footnotes

respectively) as silent witnesses to the expedition, experiment, or research that serve as the guarantors of truth claims. For him it is more than that gesture. He claims that "reference is . . . our way of keeping something *constant* through a series of transformations. . . . What a beautiful move, apparently sacrificing resemblance at each stage only to settle again on the same meaning, which remains intact through sets of rapid transformations" (58). The difference between "keeping something constant" and maintaining the "same meaning" often remains unacknowledged in Latour's arguments.

After initially arguing that both scientific and critical texts use specimens and footnotes to indicate the trail of referents in the movement he calls circulating reference, Latour later argues that scientific texts are fundamentally "different from all other forms of narrative" in that they speak "of a referent *present* in the text, in a form other than prose: a chart, diagram, equation, map, or sketch" (56). Of course, art history often does the same by including a reproduction of the image being discussed alongside the text, so this is not a fundamental difference between criticism and science. Nor do the mathematical and graphic translations used in scientific discourse offer an inherently less corrupted inscription than prose. Like prose they too are only approximate translations of the material world. Despite his seeming adherence to a philosophy that acknowledges the constructed nature of all knowledge, Latour also seems to insist on a metaphysics of presence in scientific discourse. While I agree with Latour that knowledge is generated through a chain of inscriptions, I find that it is important to acknowledge the technology that allows the production of this chain because doing so makes us more aware of the problematic nature of translation and returns us to the political realm of the agora.

At times Latour's language recognizes the impossibility of perfect translation, the selection of meanings and the accrual of meanings that transform bodies into discourse. For example, he says that we are obliged to "maintain the traceability of the data we produce with minimal deformation (while transforming them totally by ridding them of their local context)" (47). As it turns out, in the scientific report of this expedition's findings, the answer to the question they set out to address (is the forest advancing on the savanna or is the savanna advancing on the forest?) is provisionally located precisely within that excluded context in the body of a worm. Likewise he says of the various technologies the scientists use to translate the soil and foliage into patterns: "All these empty forms are set up *behind* the phenomena, *before* the phenomena manifest themselves, *in order* for them to be manifested" (49). Thus he argues that scientists use technologies of inscription to set the staged performance of information and enable the unifying gaze that produces scientific knowledge, a knowledge that must be structured at least in part by the forms that make knowledge possible.

And yet, at other times his language denies the impossibility of perfect translation and implies that such technologies of inscription do not transform the performers via this stagecraft. In speaking of the work of the pedologists on this expedition, Latour argues that as the soil samples are placed into the pedofil (an apparatus designed to compare soil samples visually by arranging them in rows) "the piece of earth benefits from a means of transportation that no longer transforms it" (51). Here we find Latour accepting such a minor act of translation as a transubstantiation, as if the soil remains unchanged by this metonymic movement into pedologic technologies designed to bring the world into discourse.

Latour's notion that the soil remains unchanged while additional meanings (those "benefits" to the soil itself) are accrued by its inclusion in the technological apparatus denies that any act of translation occurs on this level. Likewise, Latour says that "René does not *impose* predetermined categories on a shapeless horizon; he *loads* his pedocomparator with the meaning of the piece of earth–he educes it, he articulates it" (49-50).

What he has described is a moment in the process of translating the soil into pedology, but in this description what is loaded into the pedocomparator is "meaning" rather than soil. The transformation into discourse has occurred off-stage, prior to the articulation, and the soil has managed to name itself. The technology of inscription is not allowed to do its job, to move the soil into discourse by arranging the samples metonymically and thus help the scientist to categorize the samples along the clay/sand axis. Latour wants to spotlight the roles played by the scientist and by the soil in this performance while keeping the role played by the "empty forms" offered by this technology of inscription off stage in order to resist the idea that the meaning produced by such a process comes from the stagecraft itself.

Latour seems to want a transparent technology of inscription at this level, one that allows the interaction of humans and nonhumans to produce real knowledge of the world without acknowledging that the technology might shape the meanings thus educed. The approximate and "richly vascularized," to use Latour's own terms, nature of any knowledge based in the process of metonymic sampling cannot be a translation without "gaps." His periodic insistance that metonymy does not produce gaps, or at least not gaps that we generally notice, seems in

conflict with his understanding of the networks that produce such technologies of inscription and with his later definition of truth as contingent upon the ongoing movement of translation via such technologies. I will discuss the necessity of this movement and its consequences for the agora later in this chapter.

Latour finally argues that "only the movement of substitution by which the real soil becomes the soil known to pedology counts. The immense abyss separating things and words can be found everywhere, distributed to many smaller gaps between clods of earth and the cubes-cases-codes of the pedocomparator" (51). Two things are going on in this passage. First, Latour is locating meaning not in the things themselves nor in the intentions of the scientists, but rather in the movement of technologies of inscription, and in the networks that generate and are generated by this movement. Second, he is trying to deny the role played by those "gaps" that he didn't want to find by dividing them up among the technologies of inscription. He argues that we "never detect the rupture between things and signs, and we never face the imposition of arbitrary and discrete signs on shapeless and continuous matter. We see only an unbroken series of well-nested elements, each of which plays the role of sign for the previous one and of thing for the succeeding one" (56).

And yet, he has himself found the abyssal gaps everywhere, distributed among all the technologies of inscription he describes. Ultimately, whether he chooses two extreme points along the chain of circulating reference (the soil and the final report on its condition) or "multiplies the intermediaries," he finds "this same discontinuity. Yet there is also a continuity, since all the photographs say the same thing and represent the same forest-savanna transition, made ever more certain and

precise at each stage" (57). Of course, all the photographs do not say the "same thing." While they may all contain some reference to the forest-savanna transition because they were taken during the expedition, the maintenance of this reference depends upon the discourse that accompanies them. Without such discursive explication, Latour's readers would have no idea that this was a referent pictured in the photographs. Moreover, other information is available in the photographs that makes each of them speak about things other than the forest-savanna transition. Latour states: "Space becomes a table chart, the table chart becomes a cabinet, the cabinet becomes a concept, and the concept becomes an institution" (36). But the movement from space to table chart also implies the prior existence of concepts of charting, of sampling, of metonymy. One technology of knowledge always hides another. One cannot stop the movement of these technologies to secure the self-presence of a natural world that would connect discourse directly to the real.

Negotiating the Corporeal

Latour finally argues that "knowledge derives from such movements" and that "the world can return to confusion at any point along this displacement" if we cannot keep the translations moving (39). This description brings us back to Lyotard, where knowledge is the result of "heteromorphous" language games where "any consensus on the rules defining a game and the 'moves' playable within it must be . . . agreed on by its present players and subject to eventual cancellation" (Lyotard 66). Those "present players" now include, thanks to Haraway and Latour, the "nonhuman actants" that can also change the contract through their performances. They also include, despite Latour's periodic resistance, the technologies of inscription and the forms of discursive embodiment they allow.

While Lyotard would argue that knowledge has been redefined as separate from truth, Latour allows scientific reports to claim a "truthfulness" located in the sustained movement of knowledge. For Latour, a scientific report is "truthful only on condition that it allow for *passage* between what precedes and what follows it" (67). "Truth value circulates here like electricity through a wire, so long as this circuit is not interrupted" (69). As long as we maintain the networks within which particular truths are supported, Latour argues, they remain true. Alternatively, once we cease to support those networks they become false. Truth and falsity can only be determined relative to the networks that generate relations among humans and nonhumans. Since these networks are formed via the distributed agency of both humans and socialized nonhumans, Latour argues that this relativism is not the absolute relativism of a radical break with reality. Latour argues:

> Constructing a phenomenon in successive layers renders it more and more real within a network traced by the displacements (in both senses) of researchers, samples, graphics, specimens, maps, reports, and funding requests. For this network to begin to lie–for it to cease to refer–it is sufficient to *interrupt* its expansion at either end, to stop providing for it, to suspend its funding, or to break it at any other point. (76)

This version of truth is not guaranteed by any direct connection to a stable reality that we might master through our knowledge of it, but it is still based in the messianic promise of knowledge as a technology that allows us to manipulate the relations among humans and nonhumans. As such it functions more like Keller's notion of efficacy than like any definition of truth we might have expected.

Latour's argument for scientific truth is similar to Haraway's notion of scientific research as a corporealization that is not inherently a fetishization.

Haraway's notion of corporealization does not, however, have to rely on the language of "truthfulness" that creates such difficulty for Latour. Latour is aware that he has faced a recalcitrant language that had no words that would allow him to "jump. . .over construction and truth" (266). What is missing, according to Latour, is a term that would allow us to speak about the world and about scientific practice without demanding that we make a choice between the fabricated and the factual that implies a choice between illusion and reality. He proposes the "factish" as a term that acknowledges that "*because* it is constructed it is so very real" (275). Latour's neologism is ultimately less useful than Haraway's "corporealization" as it still implies the polar opposites he wishes to undermine, while Haraway's term emphasizes the process of knowledge formation. In Chapter 6 I will return to a discussion of Latour's and Haraway's solutions to the difficulties of negotiating a realist relativism that might help enable a liberatory politics for a new kind of critical enterprise that Haraway describes as a process of bearing witness and Latour describes as a process of inventing the collective. First I will need to consider the nature of language and the consequences of linguistic citationality, the relationship between archivization and the deferred truthfulness Latour grants to scientific knowledge, and the challenge presented to liberal humanist subjectivity.

CHAPTER 3
THE WORD MADE FLESH: ANTECEDENTS AND CONSEQUENCES OF LINGUISTIC METAPHORS FOR DNA

"But science is enclosed in its explanatory system, and cannot escape from it. Today the world is message, codes and information. Tomorrow what analysis will break down our objects to reconstitute them in a new space?" – François Jacob, *The Logic of Life*

"Unfortunately, we do not know how the cell decides among the possible interpretations. In working out the interpretive rules, it would certainly help to have very large numbers of different gene sequences, and I sometimes suspect that the claimed significance of the genome sequencing project for human health is an elaborate cover story for an interest in the hermeneutics of biological scripture." – R. C. Lewontin, *Biology as Ideology*

While one of the central metaphors shaping DNA research and DNA's cultural iconography has been the notion that DNA functions as the "language of life," there are a variety of discourses implicated in the historical and current uses of that metaphor. There are, of course, the obvious theological overtones from the Gospel of St. John (1:1-14), as well as those found in literary and natural history texts that sought proof of God's presence in the complexities that abound in "The Book of Nature." Moreover, from Cold War research into cryptography and

cybernetic theories of information, through structuralist linguistics and generative grammar, to post-Fordist capitalization and bioinformatics, prevalent political, academic, and cultural discourses and metaphors have shaped the development of DNA as an actant in the formation of scientific and cultural knowledge.

They do so by facilitating particular research avenues and influencing the powerful institutional structures that are differentially invested in these discourses. By enabling particular causal models and excluding others, metaphorical representations shape the types of questions scientists ask, the types of studies governments, businesses, and organizations choose to fund, as well as the presentation of research results and the design of subsequent research activities. Moreover, metaphors are brought into a discourse as part of particular discursive strategies and the form they take depends on both material and rhetorical factors active within that discursive network.

While not all metaphors are equally effective actants in generating the "powerful situated knowledges" Donna Haraway describes, DNA's construction within linguistic paradigms has been a powerfully efficacious exercise, one that continues to shape genetic research and evaluations of research results. By tracing the interactions among such discourses and DNA research and enculturation, this chapter will offer an analysis of the metaphors active in DNA discourse in order to provide a brief review of their history and some anticipation of their potential consequences. By examining the efficacy of the metaphor to determine when it works well and when it does not, I hope to show how its use offers challenges to the theories of language active in most invocations of genomes as linguistic objects. Ultimately, it is one's definition of language that determines the nature of the fit

between DNA and language systems as well as the usefulness of the metaphor in scientific research.

The Information Paradigm

In *Who Wrote the Book of Life?* Lily E. Kay provides a detailed history of the many ways that scriptural, cryptographic and linguistic metaphors have been used in researching and socializing DNA. Her express purpose is to explain the emergence, scope and limitations of viewing DNA as a language or code in the context of the information age. Her project is offered as a poststructural history, one which interrogates the discursive conditions that allow for the creation of knowledge while recognizing that "discursive conditions are not purely linguistic" (xvii). Both Kay and I use the term discourse in its Foucauldian sense to indicate "a *system* of linguistic *dispersion* . . . grounded in micropractices that vary with different cultural or historical eras" (18). These systems of dispersion include the performances of what Latour called nonhuman actants socialized into the collective through the technologies of inscription within a given discourse.

Writing from a poststructural perspective, Kay's history seeks to portray the process of scientific knowledge production as neither objectivist nor constructivist, but rather deconstructivist as the result of an interactive performed being-in-the-world whose performative flow can never be fully reduced to essentialisms (xviii). She describes the fabric of scientific knowledge and cultural practices in terms reminiscent of Haraway's corporealizations. Her history portrays the activities that produce scientific knowledge and technologies as sociotechnical, as processes that work precisely "because they are embedded not only in material practices but also in cultural practices" (18). Like Latour's

"factish," the knowledges they produce are both constructed and therefore very real, calling into question the traditional dichotomy between construction and revelation. In part, they do so because these discursive practices are not merely the result of "interest-driven, or strategic manipulations, for they are not always conscious acts, but rather reflect larger cultural forces at work" (16). It is, in fact, the very unconsciousness of such operations that once again challenges the notion of human sovereignty over the self and the self's language and indicates that it is in many ways "the writing itself that writes" (xviii).

Such interconnected networks of the material and the conceptual generate the fluid dynamics of existence, and in these flows we struggle to move with some currents and against others from our current location within the swirling fluid networks composed simultaneously of embodiment, idea, and movement. The humanities and the sciences offer methods of navigation that are as much a part of this flow as they are ways of controlling our movement within it. We have a type of agency here, but not full control. We are as fluid as our networks; they are part of our composition as we are part of theirs. Our boundaries are not the rigid dividers between inside and outside that we have so often perceived them to be.

Based on her detailed genealogy of the metaphors engaged in technoscientific knowledge production surrounding the problems of biospecificity and heredity, Kay finds that use of linguistic metaphors in these areas was initially shaped by Cold War interest in cryptography. Kay argues that there were "neither messages, information, nor texts in the pre-World War II era" of research into biochemistry (49). The dominant metaphors engaged in the 1940s were based in Emil Fischer's lock-and-key hypothesis, which described the "fit between reacting substances and

the complementarity of their three-dimensional configurations" as the process that determined biological specificity (43). Thus form was related to function prior to the influence of information theory during the Cold War. Throughout the 1940s Kay argues that the metaphors used to describe molecular biological systems were primarily those of "patterns, templates, molds, lock-and-key, die-and-coin, and photographic and phonographic negatives" (51). While Kay finds "the imperatives of material structures and processes of the gene" at work behind such earlier metaphorical representations, she does not find embodiment or semantic meaning shoring up the claims of those who equated biological specificity with information as defined by post-war cryptographic and cybernetic research (67). While the transition from "specificity" to "information" was possible because both "signified the complementarity of highly ordered biological structures," they "were not equivalent representations" (41).

The transition from metaphors of biological "specificity" to linguistic and cryptographic metaphors occurred simultaneously with the transition from the protein view of genes to the nucleic acid view of genes. Kay argues, however, that "DNA did not merely assume the specificities attributed to proteins; instead, it would be elevated to the originator and sole bearer of biological information–the prime mover" (52). Kay argues that while "specificity" functioned as Aristotelian material cause, "information" functioned as Aristotelian form (41). For Kay, the earlier metaphors retained the semantic content of an embodied form interacting with another embodied form which made them more appropriate as metaphors for genetic processes. This argument indicates that neither early molecular biologists nor Kay think of language as a material, embodied process. Language does not,

however, function in some vacuum of immateriality. Language both requires embodiment and affects embodiment, it is constituted by and helps constitute the systems of difference that position humans and nonhumans within particular collective networks.

Still, Kay identifies an important rhetorical slippage necessary for genes to be viewed as transcendent biochemical messages within an "information" paradigm. She argues that molecular biology had to simultaneously make use of both the colloquial and the technical meanings of "information" so that the very body and biochemical processes about which it spoke could be ignored. Kay distinguishes between information theory and information discourse, clarifying that information theory was adamant about the distinct technical definition of information as a statistical measure devoid of semantic content while information discourse, which was used to justify the notion that genes operate linguistically, failed to maintain that distinction. Kay summarizes:

> Contrary to its generic use, "information" in the mathematical theory of communication implied that information had to be thought of in a manner entirely divorced from content and subject matter. . . . In particular, information must not be confused with meaning. . . . Moreover, information is not an entity. . . . The Wiener-Shannon measure of information is a purely stochastic phenomenon concerning the statistical rarity of signals. What these signals signify or mean, or what their value or truth is, cannot be gleaned from the theory of communication. (20)

In order to open linguistic structures to mathematical study and use in electronic communications, the "information" content was reduced to include only consideration of syntactic pattern. Hence, a message of high information content might have no sensible meaning, since high information content only signals the

quantified presence or absence of pattern, or syntax, and not the presence or absence of meaning, or semantics. "Information" within this narrow technical definition reduces the term to the indication of pattern alone without a meaning-generating network or context beyond the distinction between pattern and noise. And yet, "information" became the term used by molecular biologists to indicate specific molecular patterns as well as their translation into the functional operations of biological systems, which are obviously part of many contextual networks that generate meaning.

As Kay points out, "even if it were possible to determine mathematically (in bits) the information content of a genomic message or a 'sentence' in the Book of Life, this would not yield any semantics, not unless its context (genomic, cellular, organismic, environmental) could be properly specified" (21). The problem here, however, is not with the metaphorical description of DNA as a linguistic entity, but rather with the application of mathematical forms and tropes of coding and decoding without regard for the "semantics" of embodiment. This problem illustrates how meaning develops from the movements and concretions of matter and idea within networks of signification rather than from the essential identities of any piece of "information." Even the process of coding and decoding occurs within a network of contexts, from that of the language being encoded or decoded, to the purposes for which coding is desired (military, business, personal, etc.), to the transmission, storage, and retrieval mechanisms being used to code, move, or hold such "information." Moreover, codes only "carry" meaning via their relationship to languages, and languages only "carry" meaning via their relationship to the networks of difference of which they are a part.

Kay argues that such abuses of information theory in information discourse offered nothing more than "a metaphor of a metaphor and thus a signifier without a referent, a *catachresis*. As such, [information] became a rich repository for the scientific imaginaries of the genetic code as an information system and a Book of Life" (2). The metaphor operated "as an interdisciplinary and cultural medium of exchange" that resonated with "multiple historical allusions and contemporary referents, eliciting imagery of transcendent knowledge" (29, 14). During the Cold War such images encouraged funding for the "codebreaking" activities of Henry Quastler, George Gamow, Francis Crick, and others for whom breaking the code became tantamount to understanding the secret of life.

For Kay the failure of such "codebreaking" activities that relied on cryptographic analysis rather than on a direct interaction with biological materials through scientific experimentation indicates the failure of the code metaphor, while Nirenberg and Mattaei's cracking of the code "represents a victory of material ingenuity over Pythagorean ideals" (255). Material ingenuity clearly makes use of conceptual ideals as well, but it remembers that the material one is trying to socialize into the collective must be made to speak via the stagecraft of our technologies of inscription. What Quastler, Gamow, Crick, and other aspiring "codebreakers" failed to consider was the neccesity of that stagecraft and the fact that even codes only "carry" meaning within material discursive networks. The "secret message" of a code or a gene can only have meaning within embodied systems of difference, both linguistic and organic, so learning to read a particular code or message requires interaction and experience with the system of difference within which that structure of code or message may be said to have meaning.

While it is true that ignoring the "semantic" content of embodiment generates more overtly ideological discourse than does a discourse that engages embodied material in its technologies of inscription; and while it is also true that these instantiations of the "code" metaphor facilitated such ideological discourse under the particular disciplinary and social conditions of the 1950s; it is not certain whether "code" or linguistic metaphors in general call such ideology into being as a matter of their own internal structural dynamics as Kay often seems to claim. Rather, as Evelyn Fox Keller argues in *Refiguring Life*, the "discourse of gene action" predates both information and code discourse, and had already established a notion of the gene as "part physicist's atom and part Platonic soul–at one and the same time a fundamental building block and an animating force" (9-10). Keller summarizes:

> In 1900 Mendel was rediscovered; in 1902 Mendelian 'factors' were tied to chromosomal structures; the term *genetics* was coined in 1905 and *gene* in 1909. In 1915 T. H. Morgan published *The Mechanism of Mendelian Heredity*; in 1916 the first genetics journal was founded, clearly marking the fact that a new discipline was off and running. For the new geneticists, the distinction between *genotype* and *phenotype* (introduced by Wilhelm Johannsen in 1911) provided a useful lexicon for distinguishing the problem of hereditary transmission from that of embryonic development. . . . Indeed, the emergence of genetics coincided with the redefinition of the term *heredity* to refer exclusively to transmission. (4)

Keller argues that these early geneticists created a framework for subsequent research in the then embryonic discipline of molecular biology that already constructed genes as virtually immortal structures with the innate power to transmit and generate "life." As Keller points out, "the first generation of geneticists–

Morgan and his school–did more than develop the techniques and practices of genetics as a rival to embryology; they also forged a way of talking about genes" (9). This new way of talking presented hereditary transmission as solely nucleic genetic transmission, thus eclipsing both the cytoplasmic body as a site of inheritance and the fundamental problems of interest to embryologists. Moreover, it posited nucleic genes as both the "building blocks" and the "animating force" behind heritability.

"Law-Code and Executive Power"

While many other histories have attributed the origin of the code metaphor to Erwin Schrödinger's *What is Life?*, Kay argues that his notions of an "aperiodic crystal" and a hereditary "code-script" "remained firmly grounded in older discourses and representations of life," namely those "1930s idioms such as 'pattern', 'plan', and 'design', which formed the discourse of organization"(61). As Kay points out, viewing organisms as hierarchically organized systems was "modeled after ideas of division of labor (which themselves drew on visions of society as a body)" (46-7). Kay further argues that "Schrödinger's code-script was based on permutations in proteins, not a *relation* (as codes technically are) between DNA and protein. It neither related one system of symbols (nucleic acids) to another (amino acids) as did genetic codes after 1953, nor, most importantly, did it claim to transfer information" (62). Schrödinger's examination of biological systems was an outgrowth of his interest in "*negative entropy* as the hallmark of life" (64). As *What is Life?* was being printed, Kay argues, cybernetics and information theory were redefining information as negative entropy, "sweeping Schrödinger's representations into the cybernetic groundswell" (64).

For Kay, to portray Schrödinger's text as the first use of information discourse in molecular biology is to retroactively create a "founding father" mythos which is unwarranted. And yet, while resituating Schrödinger's 1944 text within the then dominant metaphors of hierarchical organization clearly indicates the differences between his notion of coding and later cryptographic and cybernetic theories of information, it also points to the fundamental value of metaphor as a means of knowledge creation. Precisely because metaphors are slippery, because they are polyvalent and speak in many ways at the moment of their appearance and in subsequent invocations, they allow the movement of meaning, the flow of connections and reconnections that help generate knowledge. Kay occasionally seems to regret that play in her desire to freeze such movement and grasp the "truth" of Schrödinger's text at the moment of its publication.

The impact of Schrödinger's *What is Life?* on the central issues of concern in the early days of molecular biology was largely a result of the text's engagement with currents of thought surrounding the shift from vitalist to materialist biology. By offering the reassurance of a highly organized and stable molecule (the "aperiodic crystal") at the core of "life" in the face of the entropic threat of the second law of thermodynamics, Schrödinger offered his contemporaries a vision of biological mechanisms that preserved a version of individual immortality. He retained a hidden element of vitalism within a materialist vision of "life." As Keller pointed out in *Refiguring Life*, the problem Schrödinger sought to address was "the extraordinary stability of genetic memory in a world in which everything else was mere grist for the relentless forces of dissipation" (46). Significantly, he could not accept the notion that "life" survives merely because it consumes materials from the

environment, arguing that what living organisms consume must contain a "precious something"else.

For Schrödinger, what keeps the mechanisms of heredity and "life" from dissipation is the consumption of "negative entropy" (Keller 67). Schrödinger argued that the "device by which [life] maintains itself. . .really consists in continually sucking orderliness from its environment" (qtd. in Keller 68). Keller argues that this molecular device with both "law-code and executive power" already figures "the uncanny order of the body as a product of an intelligence system–such as the army or the state–indeed, a system also quite akin to the systems of 'command, control, and communication' that Norbert Wiener and his colleagues were just at that time beginning to develop" (75). Moreover, despite Kay's argument that Schrödinger's code was not a true code, his notion of a molecular "code-script" with both "law-code and executive power" does signify a "relation" between the notion of genes (then conceived as proteins and the biochemical source of hereditary constants) and the embodied forms that must carry out the orders they give. While Kay argues that Schrödinger's "code-script" was not technically a code because it did not relate one set of symbols to another, it did relate the theorized "code-script" in the form of the "aperiodic crystal" to the problem of life's perceived negative entropy, its power to survive, and it did so through the metaphorical use of a crystal that is also a code, which implies the actions of reading and writing.

According to Kay, linguistic and particularly code metaphors indicated a kind of transcendent message prior to embodiment that is misleading. For Kay, what such metaphors brought into genetics was a new characterization of heredity,

or rather of the immortality we so often seek in heredity, that is undermined with any close examination of biological specificity. One could, of course, argue that such a notion of hereditary as a form of immortality had long been active despite knowledge of biological specificities that undermined such notions. Moreover, one could argue that linguistic paradigms for DNA research do not necessarily have to result in this occulting of the semantics of embodiment. Language is not immaterial. In either case, whether described as a lock and key mechanism or as the linguistic transmission of a prerecorded message, the genetic material was theorized from the start as a biological site of fixed structures and their hereditary transmission.

The concept of heredity, whether metaphorized as linguistic message or viewed as a physical biochemical interaction, provides "transcendence" from the outset. Genes are, first and foremost, our conceptualization of the minimal elements of heredity. Whether at a time when we thought they were proteins or when we learned they were composed of nucleic acids integral to the creation of proteins, they have always been the conceptual equivalent of heredity elements, and as such they have always carried our notions of permanence, immortality, and transcendence of death in progeny. For Kay the greatest problem with the human genome project is that it promises a great deal more than it can realistically hope to deliver while the biopower it generates for a variety of institutions facilitates many dangerously deterministic narratives. Yet, the biopower Kay fears as an outgrowth of the increasing "geneticization" of society cannot be countered by throwing the metaphorical baby out with the bath water. Rather, viewing DNA as the "language of life" can be made to operate in both discourses of legitimation and in discourses of delegitimation.

Transcendence, Mastery, and the "Lexicon of Life"

The excessive claims made during the early days of molecular biology to a future of total knowledge and control of biological processes through knowledge and control of genetic material were what Canguilhem would call a "scientific ideology," something that is necessary for the formation of any new scientific enterprise. It creates a disciplinary space which will later be filled by a less ideological science. This shift occurs in part because as the discipline develops and socializes new materials into the collective their own performative agency is engaged and counteracts the ideological claims of mastery made on behalf of the discipline. As Keller argues, "a funny thing happened on the way to the holy grail. . . . The dogmatic focus on gene action called forth a dazzling armamentarium of new techniques . . . and the information yielded by those techniques is now radically subverting the doctrine of the gene as sole (or even primary) agent" (22-3).

The appearance of discourse about the transcendent immortality of genes and discourse about our potential to control our genetic futures is less a result of the metaphorical description of DNA as language than a result of a new discipline's struggle to establish itself and then to expand its influence. Such claims are generally the result of attempts at seducing funds and recruits to join the new cause rather than purely a function of the metaphorical descriptions invoked to support such efforts. The early days of the human genome initiatives were full of such rhetoric. It is no accident that notions of a future offering total knowledge and total control of our genomes appear most frequently today in funding requests, in promotional materials designed to generate a welcoming social climate for such research, in attempts to use the biopower generated by such discourse within

institutions such as the court system, and in warnings from groups opposed to particularly threatening aspects of such research and the biopower it generates. What they speak to is our understanding of the scientific enterprise as one which represents in order to intervene and the function of rhetoric in such a space. While viewing genes as linguistic entities clearly facilitates such theological imaginaries as "The Book of Life" and "The Code of Codes," it is hardly the origin of the notion that hereditary processes offer a version of immortality. Nor will purging our descriptions of DNA of all linguistic metaphors help to undermine such notions. Quite the contrary, as this dissertation seeks to illustrate, viewing DNA as a language may in fact offer methods of resistance to such positivist illusions of potential mastery.

Geneticist Robert Pollack focused on the analogy between DNA and language in *Signs of Life: The Language and Meanings of DNA* and found that metaphor reshaping his concept of the genome. Pollack uses Ferdinand de Saussure's concepts of the signifier, signified, and referent to explain the operation of DNA and resist what he calls the "overreaching" claims for *the* genome. Like the linguistic signifier and signified, the gene and the protein it signifies are defined only in reference to other forms and other meanings. There is no one to one correspondence between a gene and a protein, just as there is no one to one correspondence between a word and what it signifies. Pollack points out that genes, words, proteins and word meanings are all polysemic and depend on their role within a contextual frame in order to mean anything.

Once a particular set of proteins signals the regulatory region at the end of a gene to start translation, an RNA copy is assembled, edited to remove the repeating

sequences of introns, and sent into the cytoplasmic body to form a protein. The process of editing the intron sequences is a source of polysemy in that these sequences can be trimmed in a number of different ways, thus "multiplying the final meanings of a gene before translation by unpacking two or more edited versions of a transcript from a single gene's DNA sequence" (Pollack 78). Another source of polysemy is the "redundancy in the genetic code" whereby "two or more DNA sequences may in fact encode the same protein by using redundant codons to order the assembly of the same amino acid sequence" (83). Amino acids fold into the variety of shapes that give proteins meaning within the differential sign systems of this molecular architecture.

Pollack's description of DNA as a language built on context generated meaning rather than on a direct connection between each gene and a particular protein resists the notion that genome maps represent blueprints and builder's craft for generating living biological systems. And yet, Pollack's own initial metaphorical presentation of the genome as the sacred book, the Torah within the temple of the nucleus, is as problematic as the notion of the genome as blueprint. He eventually abandons the metaphor of the sacred book, and it is significant that he does so because there is no such thing as the "perfect" or unique copy of either the book or the genome. Consider the following passage:

> But do "new biological advances demand a continuous readjustment of ethical ideas"? The human genome is a text, but not a sacred one. As the six versions of one line from the Book of James show, even words held sacred by millions of people turn out to have many equally valid versions when examined closely; how much less likely is it that there will ever be a single, canonical human genome whose precise alleles we might hold up as perfect, sacred, or even special? (63)

Seemingly unaware of the connection, Pollack has identified by this comparison that thinking of DNA as a sacred book invoked a call for a transcendental signified that would stop the play of allelic difference.

Of course, in a sign system, or a living system, where meaning is generated via that play of difference, all attempts to freeze the movement of polysemy are dangerous. Pollack recognizes the danger of what Haraway calls "hardening of the categories," and calls everyone to engage in resistance. He also argues that the assumption that a perfect genome is possible "underlies a significant portion of current biomedical research and development" and that when science offers us such a dream, "we are all obliged–as bearers of different but equally valid versions of the genomic book–to recognize the temptation and forswear it" (63). Consistent with his use of Saussure's notion of sign systems, Pollack finally argues that genomes are structured as lexicons rather than sacred books.

Replicating Heroes and Sublime Objects

While Pollack is interested in examining DNA's linguistic polysemy, Richard Dawkins must ignore it to keep his replicating hero alive within the capitalist evolutionary narrative he advocates. Dawkins's argument in *The Extended Phenotype* makes a case for the gene as the fundamental unit of evolutionary selection (1). In order to respond to "pluralist" arguments such as Keller's, however, Dawkins is forced to argue by turns that his "replicator" is imperfectly copied and thereby not immortal, but at the same time "potentially immortal" (85, 87). The theories of adaptation and natural selection that together make up the theory of evolution seem to require just such an individual unit on which selection

can act. But there is more going on in such discourse than the differential survival of genes.

As Haraway and others have argued, the gene is a node of interaction where both human and non-human actors generate meaningful stories and identities. Dawkins recognizes the role the gene plays within such "nodes" when he says, "The whole purpose of our search for a 'unit of selection' is to discover a suitable actor to play the leading role in our metaphors of purpose" (91). As an advocate of neo-Darwinian evolutionary theory, Dawkins must locate a hero for his historical narratives. He argues that, "since we must speak of adaptations as being for the good of something, the correct something is the active, germ-line replicator" (91).

But must we, in fact, speak of adaptations as being for the "good of something?" What in the present motivates this "teleonomy?" In *Who Wrote the Book of Life?* Kay defines the shift from teleology to teleonomy as follows:

> The cybernetic model of goal-directed, negative feedback systems provided for Monod a legitimation of teleology sanctioned through the new biological concept of *teleonomy*, based on the goal-directedness of computer programs. (Teleology, which accounted for the open-ended adaptation of organisms to their environment, was replaced by teleonomy, the notion of a finite storage of genetic information; adaptation then became merely the activation of preexisting information.) (196)

Dawkins glosses "teleonomy" as "teleology made respectable by Darwin" in a science whose "major preoccupations will presumably be the question of the units of selection, and of costs and other constraints on perfection" (294-5). The ancient narrative of movement toward that perfection which is salvation echoes in such an analysis of constraints on its achievement.

Such narratives of purpose are manifestations of a discourse that calls for causal relationships and judgments of relative "fitness" rather than simply for an analysis of the differential patterns of development and extinction. Speculation as to what traits made a particular organism more or less well suited to its environment are always already embedded within then current political, economic, psychological, and cultural discourses. Perhaps we would be better served if our descriptions remained focused on patterns of difference rather than on teleological narratives of success and failure that presume particular values. Moreover, as Keller, Kay, and Doyle have pointed out, the effacement of the organism in such gene-centric arguments removes the very context in which their properties can have any meaning or be acted upon by natural selection (which ought to be called "differential patterns of formation and extinction" instead to get us away from the notion that some*thing* or some*one* takes the action of selecting).

The Extended Phenotype is truly a discourse of what Haraway calls the Second Christian Millennium. Dawkins's "replicators" are nodes of interaction where genetic histories are told; stories of differential survival where individual organisms are the ghostly by-product of a molecular struggle which even the etymology of "phenotype" implies. We must ask ourselves what "metaphors of purpose" can such an erasure of the organism's role in the evolutionary drama serve, as well as how the notion of perfectibility is being motivated in such narratives even when one claims that there are constraints on its achievement.

Richard Doyle's *On Beyond Living: Rhetorical Transformations of the Life Sciences* offers an important analysis of the rhetoric central to what Keller called the "discourse of gene action" and of the effacement of the body that this rhetoric

requires. Doyle's focus is on the forces brought to bear by what he calls the "rhetorical software" of the life sciences. Following Jacques Derrida, Doyle argues that language "is more than two-dimensional–it is not simply signs and signifieds but rather an economy of differences that includes signs, things, and *what it is possible to say*" (4). Moreover, Doyle argues that there is never "language 'in and of itself'–rhetorics always inscribe and are inscribed in not only contexts but interfaces, wetwares and softwares, and hardwares over which 'human actors' are not so clearly sovereign" (10). From Michel Foucault's analysis of the origin and foundational rhetorics of biology in *The Order of Things*, Doyle argues that today's life sciences are as grounded in the erasure of biological specificity as those of the nineteenth century were. Based on Foucault's argument that "life" develops as a focus for scientific investigation during the shift from natural history to biology, and that this shift marks the fundamental conditions of possibility for biology's disciplinary focus, Doyle argues that the "virtual" object called "life" connects the seemingly opposed disciplines of vitalist and mechanist, or molecular biology:

> Despite their apparent opposition, both vitalism, the idea that life exceeds known physiochemical laws, and molecular biology, the science that has claimed the reduction of life to those same physiochemical laws, relied on an unseen unity that traversed all the differences and discontinuities of living beings, 'life'. . . . Life's existence is forgotten, but its unity is not; the virtuality of life is in fact what makes unity, amid the teeming profusion of the newly thickened organisms of biology, thinkable. It is a concept beyond the particularities and practices of living organisms, and it thus anchors the new science of life. (11-12)

From this perspective, the underlying erasure of biological specificity in the discourse of the life sciences has always already occurred in order that biologists might speak about all organisms, about "life" itself. Moreover, Doyle argues that

contemporary biology relies just as much on this "virtual" object in its claims for mastery as did its earlier practitioners.

One could argue, in fact, that the only use for such a universalized object of study is that it universalizes the claims made by the discipline that examines it. This was, of course, one of the major problems with *We Have Never Been Modern* in that Latour often claimed a central place for anthropology as *the* discipline most capable of completely describing networks. Unlike Latour, however, neither Keller nor Kay nor Doyle are interested in silencing their others by speaking from a position of totalized truth. Rather, their histories focus on keeping the language games moving by pursuing historical narratives of scientific activity that emphasize the role of discourse in the formation of knowledge while at the same time acknowledging their text's role as narrative performance. Theirs are some of the many stories that can be told, each of which offers a new perspective by examining the historical co-development of nuclear genetics and information theory, but not with claims of encompassing the whole of the "anthropological matrix" Latour cites. Rather, their focus is on expanding the narratives that collectively build knowledges.

What Doyle identifies as the "sublime object of biology" is this notion of "life" as an object of study that universalizes the discipline yet remains "unthought." He agrees with Kay and Keller about the geneticization of western society, arguing that organisms "have been overlooked and recast as an effect of a molecule, an extension or supplement to the real, timeless, deathless bit of immanence known as DNA" (8-9). Moreover, Doyle argues, the effect of this effacement of biological specificity must be thought of as more than a "lost choice or alternative of the past" (9). Rather, based on Deleuze and Guattari's concept of

the rhizome, he argues that "the virtual is a sacrificed other side of the statement, the 'silence' from which any speech act bursts forth. . . . a substrate that is effaced but not erased" (9).

For Doyle, the unity provided by the concept of "life" makes the virtual body of the postvital organism possible. It is this postvital body that can be portrayed as merely a "robot vehicle" for DNA. The Human Genome Projects are all based on such virtual bodies, not only rhetorically as research that presumes to speak about universalized essentials of that ephemeral quality called "life," but specifically as the human genome being sequenced is a composite genome, composed from a variety of individuals. Whether the genome scientists have been working so hard to sequence over the last two decades would even produce a viable organism is, ultimately, unknown. Moreover, the mapping efforts of most human genome projects ignore the role of cytoplasmic and developmental processes with their focus on nucleic DNA as *the* essential message that needs to be deciphered.

Doyle offers an example from recent biological research to explain the role of the postvital organism in the life sciences in his analysis of scientific reporting about the worm *C. elegans*, whose translucent body has made it a primary research organism for biologists. Doyle points out that their work on "high-resolution" physical and cell lineage maps for *C. elegans* results from the "unspoken narrative" that structures their research (19). Specifically:

> *What the map and the cell lineage diagram inscribe is the end of a story.* "That is all there is" announces the fact that there is no more to be told about *C. elegans*. It is a story about a lack, or at least the resolution of, a story. What is mapped is therefore also something other than a worm or its genome; it is the event or effect that convinces us that the story is over, resolution. (18)

Moreover, Doyle argues, while generating maps of the *C. elegans* genome offers a sense of an ending, a sense of complete knowledge and hence of mastery, the story whose ending and mastery it ultimately heralds is that of the story of "life." In claiming that there is nothing more to be known about the translucent and mapped body of *C. elegans*, biologists also mark all life as eminently mappable and knowable.

> Thus, 'resolution' here marks the displacement of the sublime object of biology, and it is itself a marker of the sublime in the hyperreal aesthetic of *C. elegans*. . . . These narratives are about the continual and constant triumph of molecular biology, a triumph that announces the absence of that "metaphysical entity hidden behind the word 'life'." (21)

According to Doyle, what comes to take the place of "life" in the age of the end of stories is information, which "persistently returns" as the postvital body, the new sublime object of biology.

This postvital organism exists as a "cryonic body, dependent on the network of technologies, people, and narratives" to achieve, or at least to maintain the belief that we can achieve, the "high-resolution" knowledge that allows us to pursue the possibility of mastery (24). As Doyle points out, "the tropes we have traditionally associated with vitality seem to be mutating" into an information discourse focused on the functions of DNA, which is often envisioned as "life" itself (25). Clearly the Human Genome Project has contributed to such discourse, bringing into being new disciplines such as bioinformatics that struggle to make sense of the overwhelming quantity of information produced by the various genome mapping projects the HGP funds.

Like Kay, Doyle says that George Gamow's vision of the coding problem as one of translation "can be seen as a rhetorical shift from the previous emphasis on the metaphorics of 'templates'" (39). Doyle argues that viewing the coding problem as a problem of translation "was and is a structuring technology of molecular biology, a technology that retools the depths of the body as a secret, even sacred archive" (40). Language operates in Doyle's argument as a technology of inscription, thus acknowledging its materiality as one of the structuring technologies with which we form and reform distributions of power within our societies.

For Doyle, viewing the body as a privileged site of sacred knowledge that was nevertheless fully available to study and thereby to knowledge was a result of the move from vitalist to mechanistic biology that left the unity of "life," and the totalizing gesture it supports, as its sublime object. The metaphorics of translation enlisted by Gamow generate the "dynamic space where the implosion between the animate and the inanimate is constantly enacted" and the molecular is viewed "as *no different from* the living" organism of which it is really only a part (42). Doyle argues that the metaphorics of translation always require a third term, or:

> a space between two codes, texts, or speakers, and Gamow's easy translation of a molecule into a chromosome points to the discursive existence of an implicit translating point between the molecular and the somatic that preceded any scientific model for such an equation. This space . . . is a space of *no difference*: in the space of the postvital . . . bodies, codes, and molecules all glide together in a universal language that is itself not available for translation or, what amounts to the same thing, does not require it. (42)

Thus in Doyle's analysis, Gamow could only have made use of the metaphorics of translation and code-script within a discipline that already viewed molecular specificity as the mirror image of biological specificity, one in which embodied

forms were already viewed as the expressions of molecular architectures, and one that required the effacement of the process of translation as one that takes up time and space and, in this case, employs actants other than nucleic DNA.

Doyle argues that what "makes Gamow's invocation of the metaphor of transparent translation plausible is a culture or 'context' of the Book, a culture whose model of life, reason, and truth is based on the translatability of the word" (48). Full of theological resonance, the understanding that "life" is readable suggests that "the problem of translation can be contained" (52). Thus, while the geneticization of culture seems opposed to older vitalist or theological societies, it still relies on an understanding of scriptural exegesis that denies the problematics of translation which are so consistently the focus of postmodern philosophy and science. This culture of the book and its insistence on the translatability of the word does not depend on the presence of linguistic metaphors in descriptions of DNA, as Doyle also points out that it is present even within the earlier metaphors of lock and key, which suggest "that everything fits together securely and that the problem of translation can be contained" (Doyle 52). Linguistic metaphors, however, have the advantage of offering a discursive opening for analysis that explicitly focuses on the problematics of translation.

Signifying Systems

The twentieth century has brought dramatic challenges to the expectations of readability required in such theological conventions. As Kay argues, "such absolute concepts of language (like the absolutes of mass, space, and time in the mechanical world picture) had already been challenged in the beginning of the twentieth century by admitting the contextualities within the knowledge-system

into analyses of meaning, by accepting the contingencies of structuralism" (35). Ferdinand de Saussure revolutionized theories of signification in 1916 with his observation that languages establish a relationship "between a *concept* and a *sound-image*" rather than between a thing and its name (Kristeva 13).

Saussure viewed linguistic signs as "a psychological reality with two sides," so that a word consisted of both its sound-image and the concept that speakers of a particular language associated with that sound-image (13). Different languages may link very different concepts with the same objects, so that what a word means is determined by the structure of differences that a particular language develops from and, simultaneously, helps make real within that discourse community. Language is viewed here as a technology of inscription through which groups of speakers are formed and from within which they negotiate their relationships with the objects and others of their world. Julia Kristeva summarizes Saussure's analysis of the sign as follows in *Language–The Unknown: An Initiation into Linguistics*:

> These two inseparable sides of the sign, which Saussure describes as two sides of the same piece of paper, are called the *signified* (the concept), and the *signifier* (the sound-image). For Saussure, the linguistic sign is defined by the signifier/signified relation; the object, excluded from this relation, is designated the *referent*. Linguistics is not concerned with the referent; it is interested only in the signifier, the signified, and their relation.

Saussure recognized that "language is many sided and heterogeneous; straddling several fields–physical, physiological, and psychological–it belongs both to the individual and to society; we cannot put it into any category of human facts, for we cannot discover its unity" (qtd. in Kristeva 8-9). Hence, the full study of language

would require radically interdisciplinary study beyond the capacity of linguistics or any other current science.

Recognizing the breadth of intertextual discourses and embodiments that any study of language would have to consider, Saussure limited the object of study for linguistics by designating *la langue* as that portion of language wherein the "auditory-image . . . becomes associated with a concept" (qtd. in Kristeva 9). While the relationship between the signifier (sound-image) and the signified (concept) was completely arbitrary in the sense that different languages had very different signifiers for same or similar concepts, they were not arbitrary in the sense that one could use any signifier to name any signified and expect to communicate. Linguistic meaning is made possible only by using signifiers according to the rules of a given language.

For Saussure, *la langue* indicates the "social side of language, outside the individual who can never create or modify it by himself; it exists only by virtue of a sort of contract signed by the members of a community" (qtd. in Kristeva 9). In this view languages are composites generated by the linguistic practices of particular language communities, "anonymous system[s] made up of signs that are combined according to specific laws" that are not the provenance of individuals but are, rather, the cumulative result of the performances of the entire community of speakers (9). In contrast, Saussure viewed speech as the result of an individual's performance within the linguistic codes of his or her language community and privileged speech as self-present and the result of "an individual, willful, and intelligent act" on the part of the speaking subject (qtd. in Kristeva 9). This understanding of speech as self-present and fully mastered by the individual speaker has since been undermined

by psychoanalytic and deconstructive analysis, but Saussure's theory of the sign is still a founding concept in modern linguistic study. His most important contribution was approaching "language as a system of relative and contrasting acoustic images–with all their attendant semantic and grammatical relations–distinguished from one another not through any absolute reference, but rather by their differences. The sign derived its meaning only from the context of the whole linguistic system" (Kay 299).

While Saussure examined the sounds produced during oral articulation to produce a systematic analysis of the smallest meaningful elements of speech, called phonemes, Roman Jakobson argued that phonemes are composed of distinctive features that require a "choice between binaries, two terms of an opposition (e.g., /P/ and /t/ are phonemes representing grave and acute sounds, respectively, with contrasting physical and physiological properties)" (Kay 299). Moreover, Jakobson "demonstrated that such binary oppositions could also be applied to other linguistic levels: syntax, semantics, and pragmatics" (Kay 299). Rather than being defined by many contrasting levels of difference, difference is here reduced to binarism, which is well suited to comparisons with machine languages and computational analysis.

Kay argues that these connections and the funding available for such investigations offered increased prospects for the previously stagnant field of linguistics (300). Jakobson, in fact, began work at MIT's newly created Center for Communications Sciences in 1958, which was affiliated with their Research Laboratory of Electronics, and "offered a 'unique environment in which to study communication processes in both natural and man-made systems'" (Kay 300-1).

Moreover, Kay argues that Jakobson's binarist information-theoretical approach to linguistics was especially well suited to the development of automated information systems, and that information discourse "reconfigured linguistics as an information science in the 1950s, as it did in molecular biology. . . . As in biology, content became form. The multidimensional organic attributes of speech and life were conceptually flattened, ostensibly captured on the imaginary tape, a logos studded with zeros and ones" (320-3). But this conceptual flattening had already occurred with Saussure's separation of *la langue* as scientific object from language in general, making linguistics a more scientific discipline by focusing its efforts on a more systematized study of a particular aspect of language.

And yet, while he demarcated the object of study as particular systems of difference generated by linguistic groups who agreed to link particular concepts to particular sets of sounds, there remained a residual connection to the function of language as a technology of communion, of communication, and of meaningful connection with referents, in short as a signifying system. Saussure was aware that linguistic theory was not capable of examining all the areas that structure and are structured by a given language, but in his call for a general science of semiology, he indicated the sublime unified object underlying all the human sciences as systems of signification. While Saussure "pointed out that semiology could not be the neutral, purely formal, even abstractly mathemetized science that logic and even linguistics are, for the semiotic universe is the vast realm of the social, and to explore it is to join in sociological, anthropological, psychological, etc., research," he nevertheless viewed the entire social field as structured by signifying systems and conceived a future science of semiology that could address them (Kristeva 297).

On the one hand, Saussure's redefinition of the focus for linguistic study to *la langue* illustrates a structural necessity of scientific investigation, as the ability to make increasingly detailed and systematized observations about any object or process requires that one narrow one's focus and address only those questions about the object or process that one is capable of asking and interested in answering. As discussed in the previous chapter, one must silence some things in order to be able to say other things. On the other hand, this conceptual flattening indicates the necessity of a "sublime object" for all scientific investigation, the purpose of which is to facilitate our belief in the possibility of mastery and the translatability of the world as Word. While, as Doyle argues, the move from vitalist to mechanistic biology retained the unity of "life" as its sublime object of study, the move from the philological (diachronic) study of language to the structuralist (synchronic) study of language likewise held on to the unified object of language as a signifying system that produced positive communication, community, and communion. Signification becomes that which makes unified systems of language and communication thinkable amid the dynamic and fluid intercourse of languages and cultures. From this perspective, the underlying erasure of the diverse specificities of linguistic and cultural practice has always already occurred in order that linguists might speak about all languages, and even about "signification" itself.

In her review of the history of linguistics, Kristeva finds that by "abandoning the historical and psychological presuppositions of previous periods" and limiting the focus of linguistic study to *la langue*, linguists managed to make their discipline more rigorous by borrowing concepts and models from mathematics, but they eventually found:

> that a mathematical model (like any formalist model . . .), once applied to a signifying object, requires some justification and is only applicable because of the implicit justification the researcher gives it. The ideology one wanted to escape from thus turned up again in latent form in the *semantic root* of the model applied to the description of language. (219)

Hence, linguistic study today "is not oriented solely toward its object, *la langue*; it is also oriented toward its own discourse, its own foundations. Every discourse about language is thus *required* to . . . become a science of its *process*, while remaining the science of an *object* (Kristeva 220).

Of course, not all linguistic study lives up to this demand for self-reflexive analysis, just as much of the scientific research being done is not of the postmodern kind Lyotard praises. Additionally, while it is within the discourse of signification that DNA becomes a language, a sign system so often imbued with expectations of transparent scriptural exegesis that deny the problematic nature of translation, the discourse of signification does not need to offer such expectations. Viewing DNA as a sign system like language does not require such a philosophy of unambiguous translatability. It does not have to be predicated on a belief that sign systems reveal truth and are thereby available for full translation. Rather, it could be predicated solely on analysis of the efficacy, inevitability, and necessity of signification as a method of negotiating differential relationships within the collective networks composed of both humans and non-humans.

Bioinformatics and Subjectivity

Bioinformatics and DNA linguistics have developed out of the discursive and institutional relationships among molecular biology, linguistics, information science, Jakobson's binarist vision of language and, later, Chomskian generative

grammar. Noam Chomsky worked with Jakobson at MIT on a dual appointment in both the Center for Communication Sciences and the Research Laboratory of Electronics, and Kay argues that "the centrality of syntactic and transformational linguistic analyses to the larger project of automation of language and mechanical translation does point to technoepistemic resonances between the theory of generative grammar and the cybernetic culture" (304). Kristeva summarizes Chomsky's theory of generative grammar as follows:

> Chomsky tried to create a new grammatical theory, a sign of the technical and scientific nature of a mathematical formulation, without having recourse to semantics. . . . In place of an *analytical* approach to structure, Chomsky proposed a *synthetic* description. The sentence should no longer be broken down into immediate constituents; instead one should follow the *synthetic process* that leads these constituents to a syntagmatic structure, or transforms this structure into another one. (253-4)

And yet, as Kristeva argues, "Chomsky's rigorously formalized theory is infiltrated by an ideological foundation, namely, the *speaking subject*" whose recognition of grammatically correct sentence structures presents us with an idealist Cartesian consciousness (254). Kristeva further argues that while Chomsky's approach offered a more dynamic and process oriented view of *la langue*, it required this "rationalistic conception of the subject," and thereby functioned as a "syntactic description of a psychological doctrine. Syntax, which used to be a science of reasoning, [became] the science of normative psychological behavior" (259-60).

What such an approach fails to account for are the diverse modes of signification and variety of functions language performs. As Kristeva argues, Chomsky's transformational grammar and structural linguistics engage in that same conceptual flattening Kay complained of in molecular biology. Semantic

embodiment is effaced in favor of a systematization designed to serve projects of automation and reinforce the narratives of mastery that science so frequently offers. Chomskian models for generative grammar are among those being used today within the newly formed discipline of bioinformatics as one way of trying to understand the enormous quantity of sequence data being generated by the human genome projects.

Even in Kay's poststructural history of the many ways that scriptural, cryptographic and linguistic metaphors have been used in researching and socializing DNA, the problem of an underlying Cartesian subject appears. In her analysis of the 1967 French television broadcast *Vivre et Parler*, Kay agrees with Claude Levi-Strauss that one of the reasons we should not view DNA as a language is that to do so ignores the fact that "natural" languages require communities of speakers that are consciously using language. The show itself was extraordinary in bringing together leading scholars from a variety of disciplines to discuss the view that DNA operates as a language. Kay summarizes the dispute that occurred during the show between Jakobson and Levi-Strauss as follows:

> Levi-Strauss, however, was not convinced by the linguistic view of life. He saw major obstacles for such analogies, mostly in the form of difficulties centering on the issue of *signification*, which had not been properly defined. . . . In language, signification applied to us, the speakers, but in molecular biology, it applied to inert molecules (and the decoder, the biologists added); there was a slippage between object and subject. . . . But Jakobson thought that the similarities between the two systems far outweighed their differences, especially if one broadened the notion of communication to include semiotics: nonverbal messages and other sign systems. . . . Levi-Strauss was not swayed. For him the whole discussion finally led to a fundamental philosophical conundrum: Can there be a prediscursive

> knowledge of language existing prior to its construction by humans? Could there be something, as biologists claim, that resembles the structure of language but which involves neither consciousness nor subject? (309-310)

Moreover, as Kay relates François Jacob's arguments on the same issue from *The Logic of Life*, she finds validation of Levi-Strauss' objection that the processes of iterability operating within cells and the processes of iterability operating within and among human speakers of a "natural" language are different because the later requires consciousness. In this text Jacob asks whether the similarities between linguistic and hereditary processes are only the result of "an epoch dominated by the theory of information" or whether they "recover a most profound 'reality'," only to determine that "the remarkable analogies between heredity and language were an expression of exigencies born out of proximate functions" (Kay 314).

Jacob's language is striking in the quotation Kay uses to support her argument that DNA does not, ultimately, function as a language:

> Language studies the messages transmitted from an emitter to a recipient. Now there is nothing of the kind in biology: no emitter, no recipient. The famous message of heredity transmitted from one generation to the other, *no one* has ever written it [personne ne l'a jamais écrit]; it is constituted by itself, slowly, painfully traversing the vicissitudes of reproductions subtended by evolution. Moreover, no one has received a true message [emphasis added]. (314)

Kay seems to agree with him despite both her earlier statement that it is often the writing that writes and her premise that metaphors shape knowledge in meaningful ways, but because he views "natural" language as a process that requires both emitter and receiver as well as message while viewing biological processes as ones

that occur without emitter or receiver, Jacob's criticism of the view that DNA functions like a language is caught within a discourse predicated simultaneously on an idealist Cartesian consciousness and an essentialist concept of DNA that denies the dynamics of molecular processes. He has not taken into account the consequences of psychoanalytic theory for such a simple notion of human consciousness as a unified and stable sender and receiver of messages. Nor has he fully taken into account the simple fact that DNA is part of many dynamic and interdependent cellular, organismic, and environmental processes. In no way is it a message fully "constituted by itself," despite the discourse of gene action Jakob engages.

Within molecular biology itself research in the genomic archives of many species have challenged the rhetoric that presents nucleic DNA as the blueprint or codescript of living organisms. The discourse of gene action that Keller examines in *Refiguring Life* and its realization in Francis Crick's Central Dogma declaring the unidirectional flow of information from DNA to protein via mRNA is challenged today by what is known of the action of retroviruses, prions, transposons, and even environmental influences that generate inheritable changes in gene function. Retroviruses (including HIV) use the reverse transcriptase enzyme to reverse information flow from mRNA to DNA. Prions are proteins that are thought to pass information directly to other proteins in such diseases as BSE (mad cow disease). Transposons reveal the fluid and dynamic nature of genomes by jumping from one location on a chromosome to another and from mitochondrial or chloroplast DNA into nucleic DNA and on to other organelles.

Moreover, while "changes in the coding sequence acquired during an animal's lifetime cannot be inherited, modifications to the way genes work, brought about by environmental influences, can be passed to offspring" (Nottingham 13-4). For example, Sup35 is a yeast protein that can change its shape to form a prion, "a protein that self-propagates by causing other Sup35 proteins to misfold and that can be passed from parent to daughter cells" (Chicurel 1825). Moreover, as a prion, Sup35 "causes the translation machinery to miss stop signals in the mRNA and create proteins with extra segments" (Chicurel 1825). The increase in genetic variability caused by Sup35's trickster transformations was shown to increase the colony's growth in times of stress, while being able to return to its normal protein shape when conditions returned to normal prevents these changes from being part of the nucleic DNA structure. Here we have a protein that forces the cell machinery to engage in differential reading strategies based on the environmental conditions in which it finds itself, one that can pass its reading strategies on to its progeny.

Rather than a stable lexicon or blueprint, nucleic DNA is part of a cellular system of iterability that requires the generation of variability perhaps as much as it does heritability. Infidelity to nucleic DNA, in fact, may have been "selected for" in the parlance of evolutionary theory. Even sexual difference itself may have developed as a kind of difference engine, offering organisms that reproduce sexually the ability to reshuffle the genetic cards to increase variability and offer potentially beneficial recombinations. Geneticists have shown how some chromosomes and parts of chromosomes are relatively stable during the recombination process while others are more thoroughly shuffled. This indicates that while some areas of the genome are highly conserved by natural selection, others areas are prone to frequent

recombination, which probably indicates that these areas are not involved in generating the most critical biochemical processes, but that their recombination may offer the potential for the creation of new genes. As we learn more about genomes, we find they are far more fluid and dynamic than we once thought and, like language, DNA does more than provide the biochemical messages, recipes, or blueprints necessary for the generation and functioning of organisms. It is a site of interaction, of communion, of intercourse where biochemical patterns engage each other in an ongoing renegotiation of boundaries and functions.

Manfred Eigen developed a novel evolutionary view of DNA and linguistic sign systems that supports a less Cartesian vision of the subjecthood necessary for the formation and use of language despite his insistence that the unambiguous assignation of meaning to signs is the precondition for any language (Kay 323). Knowing the difference between "information" in its common usage and "information" in information theory, Eigen generated a research program into the origins of life that neither looked for nor provided a fully originary point.

While Eigen "treated nucleic acid and enzyme reactions as information transfer systems, as molecular learning, storage, and retrieval" (319), he also viewed "semantics as the dynamic and functional properties resulting from a prebiotic interplay between nucleic acids and proteins. Consequently, there was no need for viewing the emergence of life as one enormously unlikely accident." Rather, life was to be viewed as the result of "random effects that were able to feed back to their origin and became themselves the cause of amplified action" (321). Kay describes Eigen's "stochastic universe of molecular Darwinism" as follows (321):

> Those fluctuations in the system that lead to unique translation and its reinforcement via the formation of a

> hypercycle offer an enormous selective advantage. Thus the emergence of life occurs through selective reiterations. Rather than being a fluke, the origin of life's information turns out to be an inevitable event. (323).

Here origin becomes only the physicotemporal locus for the current feedback loop in an iterative process that produces sign systems with "sufficient legislative and executive power" to ensure their ongoing development. Hence life is, as Eigen argued, "neither creation nor revelation. It is neither one nor the other, because it is both at once" (qtd. in Kay 321). Eigen's work on an "evolutionary reactor" based on such theories has even gained the support of biotechnology companies looking for novel (read patentable) chemicals with pharmacologic or industrial uses (Kay 322).

Like the imprint of Gravida's footstep that Jacques Derrida invokes in a discussion of iterability in *Archive Fever: A Freudian Impression*, DNA's "iterability, that is to say, its immanent divisibility, the possibility of its fission, haunted it from the origin" (Derrida 100). It is precisely because both molecules and memes can be fragmented and recombined that language and life are possible. As stochastic accretions of molecular, memetic, and cultural patterns that have achieved the quintessence of consciousness, this iterability continues to haunt our language and ourselves. It is the precondition for our existence as physico-rhetorical actors with the ability to rearrange the texts of our embodiment and write ourselves differently. And yet, it is also the long history of our coming into being that continues to shape our possible futures.

Learning to speak and/or write another language does not make one master of that language, although it offers the illusion of mastery to many who believe in simplistic theories of signification. What it does offer is efficacious access to the

new language that will allow you to use it to help shape the systems of difference that its expression effects and, in turn, is affected by. It allows you to join the community of interlocutors that generate and are generated by that language through its performative inscription, but it does not grant you full mastery of those other interlocutors, be they humans or non-humans. What will it mean for humans to enter the discursive community of molecules?

Evelyn Fox Keller has described science as a process that produces efficacious knowledges rather than truth. By efficacy she means both a definition of knowledge that has the material force of truth because it can command material forces, and one that acknowledges the role of politics in the creation and institutionalization of such truth effects. It is not only the novel reiterations of organisms that are required to respond to changes in their own interior genetic archives. Nor is it only the sciences that must alter their theories and practices to account for the implications of these genetic reinscriptions. In a variety of ways, we are all summoned into the collective that genetic archivization inscribes since all our bodies contain DNA and are thereby potential sources of raw materials and information as well as the focus of a variety of narratives embedded in genetic histories.

Corporealization vs. Commodification

The promise Haraway identifies in the Human Genome Project as a "corporealization" instead of simple "commodification" is largely unrealized to date. The conceptual tropes common in reports on genomic research found in *Science* indicate that notions of exploration and territorial claim may even be shaping that research in meaningful ways. These tropes have portrayed 95-97% of the genome

as "junk." It was thought at the beginning of the project that only 3-5% of the DNA molecule codes for genes while the majority of nucleotide base pairs are vast repeating sequences of introns with no discernible function. Since the publication of the draft sequences in February 2001, only 1.1 to 1.5 percent of the genome is thought to contain genes. Biotechnology companies have tended to focus on mapping those sequences identified as genes because they offer more potential for the creation of commodities, and sequencing entire genomes is likewise viewed as the creation of a resource that will be used to locate genes.

Science writers characterize the efforts of the few researchers who are investigating the role of "junk" DNA as "mining treasure" from the "genetic garbage can" by examining how "sophisticated maintenance and control systems [are] embedded in what was thought to be mere waste" (Nowak 608). While the frequent use of this metaphor illustrates that capital acquisition is the spirit motivating most genetic research, this focus on investigating the genome with an eye to profitable commodities may have led researchers to neglect the more significant role that "junk" DNA may play.

One study, however, covered in the November 1994 issue of *Science*, used statistical techniques from linguistics to show that "junk" DNA has "all the features of language" (Flam 1320). The study indicated that the DNA sequences thought of by many researchers as mere filler between genes have semantic content and the metaphorical connection to language may be more accurate than once thought, which could open research avenues that might have otherwise been ignored (1320). In light of the pattern of grammatical structure indicated in 95-97% of the DNA molecule it is troubling that many genome researchers tend to ignore the questions of iterability

and translation. They often view this biochemical language as simply a code that needs to be deciphered, a code that offers us the ability to control the production of human and animal bodies. Such a view of genomes facilitates the biopower Kay sought to warn us about.

With the recently completed draft sequences of the human genome and the claims being made for its potential to offer "future diaries" of our physical, mental, and behavioral attributes, we all need to understand this new "language." All to frequently the research being done under the auspices of the Human Genome Project are presented as cryptographic exercises that will reveal to us the original language of life. Moreover, DNA is increasingly viewed as the raw material or alphabet with which we should script future potentials. While therapies based on knowledge gained from studying the genome may well eventually offer treatments or cures for genetic illness, the biopower it will generate en route can also result in injustice and a reduction of our freedoms.

Simplistic understandings of language systems encourage the use of linguistic metaphors that help validate the faith in our potential mastery of the messages that traverse us, whether linguistic, biochemical or both. Since we generally feel that we control language rather than that it controls us, rhetorics that use popular understandings of language as a simple system of signification as the model for genes facilitate visions of the geneticist as an engineer and of a human culture in charge of its fate because it will learn to read, write, revise, and otherwise construct genetic texts. Postmodern challenges to such naive theories of language can, however, offer avenues for analysis that highlight the problematics of translation and call into question that faith in the mastery that technoscience promises.

Despite being a promise whose realization is always deferred, it is used to reorganize the discursive and social relationships of humans and nonhumans.

CHAPTER 4
THE FLESH MADE WORD: ARCHIVIZATION AND TRANSGENIC WRITING AS PHARMAKON

> *"As techno-science, science, in its very movement, can only consist in a transformation of the techniques of archivization, of printing, of inscription, of reproduction, of formalization, of ciphering, and of translating marks."* – Jacques Derrida, *Archive Fever*

> *"It is a question of the future, the question of the future itself, the question of a response, of a promise and of a responsibility for tomorrow. The archive: if we want to know what that will have meant, we will only know in times to come. . . . A spectral messianicity is at work in the concept of the archive and ties it, like religion, like history, like science itself, to a very singular experience of the promise."* – Jacques Derrida, *Archive Fever*

If DNA is a language, another technology of iteration that acts either through processes of representation or through processes of negotiation and translation, then revisions are thought both possible and potentially desirable. Rather than a sacred body whose alteration would be deeply suspect, we have a technological process whose manipulation becomes merely a question of technological and managerial skill. Neither the representational model of language nor the postmodern view of language outlaw the manipulation of genes when genes are viewed as linguistic agents. Rather, the linguistic metaphor, regardless of how you view

language, allows scientists to treat genetic material as just another technology of inscription and genomes as documents that could benefit from a little controlled editing to generate cures for individual and social ills.

By recording the interactions of DNA and organismic function and viewing those interactions as semiotic systems, scientists generate one of the many rhetorics that make room for their own interventions. These interventions come in the form of experimental reinscriptions at various levels (molecule, cell, organism, environment) and in the requisite analysis of the responses made by the organism(s) and environment(s) thus reinscribed. It is through this dual process of reinscription with a signifying difference and analysis of that reinscription (largely through narrativization in scientific reports on the research) that molecular biologists may learn something about, by doing something with, the systems of difference generated in these material semiotic processes.

The experimental study of genes requires the manipulation of genomic structures precisely because DNA is part of a recombinatory and iterable process that generates organisms within the constraints produced by the evolutionary history of molecular interaction. As with a "natural" language, to learn to write with genes you need only observe the "speakers" of that language in action before trying to use the language, but you will make many mistakes that those same "native speakers" must challenge and you must learn to correct before you will gain any level of proficiency. Despite the naive understandings of language that are used to support narratives of linguistic and scientific mastery, however, such proficiency is never total, even for "native speakers," as the language they use is only the

constantly mutating stochastic accretion of the performances of all users of that language.

While it may seem that genetic engineers are thoughtfully designing organisms from a DNA language that they understand and control, the production of transgenic organisms often gets results largely by accident. As Vandana Shiva argues in the Epilogue for *Biopolitics: A Feminist and Ecological Reader on Biotechnology*, thinking of genetic manipulation as a thoroughly planned, engineered process of creation is misleading:

> Thus, although the metaphor for patenting is 'engineers' who 'make machines', of the 550 sheep eggs injected with hybrid DNA, 499 survived. When these were transplanted into surrogate mothers, only 112 lambs were born. Of these just five had incorporated the human gene into their DNA, and only three produced alpha-1-antitrypsin in their milk, two of which delivered only three grams of proteins per litre of milk, but Tracy, PPL's 'sheep that lays golden eggs,' produces 30 grams per litre. (273)

While Pharmaceutical Proteins Ltd. succeeded in creating an effective "furry little factory" from which they can milk human proteins, they did not do so via a process that required full understanding and control of the organism's genome and metabolic processes (273). In fact, as Shiva points out, their success with Tracy depended on the inclusion of so-called "junk DNA," which is generally believed to have no function, that was left in the gene "essentially as God provided it" according to PPL's director (273).

Genetic language is no more a static entity with regular borders than is "natural" language. Both are constantly changing, or "mutating," with or without our conscious intervention, and both can be re-shaped by contact with other similar

semiotic systems, and these changes are complexly woven into the fabric of genomes and environments, languages and cultures. Current analysis of the human genome has even shown that bacterial and viral pathogens have integrated with the human genome over the course of millennia so that some 35 percent of human DNA is suspected of being the "fossil" relics of such cross-over (Wolffe and Matzke 481).

Moreover, both genes and words are polyvalent and their translations depend on the reading strategies that are applied to them. Both are governed by "rules" or structures that are the result of the evolution of patterns within the constraints of the physical materials engaged in pattern making. And for both what we recognize as a particular "language" or "species" with specific borders results from the institution of archontic semiologies (linguistics and natural history) culled from the accretion of semiotic performances. As such both are already imbued with the processes of law and governance that make up the political realm and are, as we will see, fundamental to the constitutional violence inherent in the archontic principle as discussed by Jacques Derrida in *Archive Fever*. Similarly, the corporealization of DNA as an actant in contemporary culture is manifest only through the institution of archontic semiologies derived from the accretion of performances that generate databases and research reports on interventions as well as the physical reinscriptions of this ultimate "mother tongue" and of all those affected by them.

Rather than Saussure's distinction between language as all its performances and *la langue* as the material features of speech accessible to linguistic study, we have here a distinction between language as all its performances and language as only

those performances that are brought into the archive as part of what officially constitutes the language (through dictionaries, grammars, periodicals, books, television, video tape, audio tape, computer memory systems, etc.). The difference is that only those linguistic performances that make it into some material substrate other than human consciousness and are thereby available for archivization can become fodder for archivists and be used to determine what we recognize as a set of language boundaries and rules. Of course, many archivists generate material for the archives by taping or otherwise recording the linguistic practices of those who do not work to archive themselves in a form amenable to use by archivists. They do so because they desire a more complete archive from which they expect to achieve greater truth in their analyses of semiotic activity and, more importantly, greater ability to control the materials and truths of the archive via claims based on assumptions about the archive's metonymically comprehensive nature. Creation and maintenance of what constitutes current scientific knowledge and practice requires archivization, as the results of new experiments and novel interpretations of existing data can only become part of a science via publication (even if only internally within a proprietary corporate structure). The Human Genome Project is clearly designed to bring the molecular archives known as genomes into the archival knowledge bases of human cultures.

The Archontic Principle and the Archivization of DNA

Jacques Derrida's examination of the function of the archive in *Archive Fever: A Freudian Impression* points to two orders of archivization, namely the sequential and the jussive. Archives hold the past but are about constitution of the future. Every archive is "at once *institutive* and *conservative*. Revolutionary and

traditional. An *eco-nomic* archive in this double sense: it keeps, it puts in reserve, it saves, but in an unnatural fashion, that is to say in making the law (*nomos*) or in making people respect the law" (Derrida 7). The creation and maintenance of archives gathers together in a specific place managed by a specific group not only a record of the past, but the authority to shape the future based on the laws these "archons" generate and maintain by grounding their claims in the rich historiography of the archive.

> The archons are first of all the documents' guardians. They do not only ensure the physical security of what is deposited and of the substrate. They are also accorded the hermeneutic right and competence. They have the power to interpret the archives. Entrusted to such archons, these documents in effect speak the law: they recall the law and call on or impose the law. (Derrida 2)

Archontic power flows at least in part from the power of consignation, the power of "*gathering together signs*" that begins by presupposing the possibility of completion and "aims to coordinate a single corpus, in a system or a synchrony in which all the elements articulate the unity of an ideal configuration" (Derrida 3).

It is this dual presumption of sequential and jussive unity as the goal of archivization, the notion that the archive offers a complete record and that it holds truths that are universally applicable, that points to the violence inherent in the creation of any archive. That violence inheres in both the totalizing gesture of archivization and in the application of laws based on the authority of what must remain a perpetually unfinished archive. As Derrida argues:

> By incorporating the knowledge deployed in reference to it, the archive augments itself, engrosses itself, it gains in *auctoritas*. But in the same stroke it loses the

> absolute and meta-textual authority it might claim to have. One will never be able to objectivize it with no remainder. The archivist produces more archive, and that is why the archive is never closed. It opens out of the future. (Derrida 68)

There is always something more to say about the material relationships engaged in and through the archive, hence archives can never truly be completed despite the overreaching claims of some archons. Headlines such as this one from the June 30, 2000 issue of *Science* illustrate the type of overreaching claims frequently made on behalf of the Human Genome Project: "Finally, the Book of Life and Instructions for Navigating It" (Pennisi 2304). Archives are created to enable such claims to mastery while simultaneously leaving knowledge open-ended, but such claims require that one forget the historicity of the archive.

In transgenic writing based on the information and materials of genomic archives, it is not only the novel reiterations of organisms that are required to respond to changes in their own interior genetic structures. Nor is it only the sciences that must alter their theories and practices to account for the implications of these genetic reinscriptions. In a variety of ways, we are all summoned into the collective that genetic archivization inscribes since all our bodies contain DNA and are thereby potential sources of raw material and information, as well as the focus of a variety of narratives embedded in genetic histories. These reinscriptions alter both the rhetorical and physical worlds we inhabit, and in doing so call us into relationships which we may not desire. They reconstitute the systems of difference that define us as physical and rhetorical beings, for better or worse.

This marriage did not, however, require that we respond directly in the affirmative as our overt consent is largely irrelevant to the process. We are already

a part of this network which has already said "yes" for us. We have already been called into the community, and the possibility of opting out (other than, perhaps, in our death) is foreclosed. Because we live in a world where social, cultural, political, economic, technologic, philosophic, and religious solutions to perceived ills each use our hope for a better future to secure their power in the present moment, if we have any hope of and for our future we are all already drawn into this relation of unconditional affirmation.

Derrida examines how an unconditional affirmation of the future which is yet to come is required when drawing juridical authority from the archival process. This "affirmation of the future *to come*" is simply "the condition of all promises or of all hope, of all awaiting, of all performativity, of all opening toward the future, whatever it may be, for science or for religion" (Derrida 68). While science is designed to bring the material world into our systems of knowledge via its various technologies of inscription, these processes of iterability can never be finished. Rather, use of these technologies is, as Derrida argues,

> a question of the future, the question of the future itself, the question of a response, of a promise and of a responsibility for tomorrow. The archive: if we want to know what that will have meant, we will only know in times to come. . . . A spectral messianicity is at work in the concept of the archive and ties it, like religion, like history, like science itself, to a very singular experience of the promise. (36)

Science draws its claims for knowledge from the promise afforded by the technology of archivization, but this technology cannot provide the kind of truth that is so often expected of it. That expectation requires that we forget the

historicity of the archive itself, its technological nature as an iterative process, and instead think of it as a process of revelation.

What archives do provide is the substrate for powerful truth effects that generally support then current social relationships, and the biopower generated by the Human Genome Project is no exception. With the February 2001 publication of both the public sequence in *Nature* and Celera Genomics' sequence in *Science*, the Human Genome Project would seem to have provided us with the full text of the Book of Life from which we can learn to read, and write, human potentials. In a way this is correct, for the biopower generated through the narratives such research promotes does shape human potentials by controlling what we think we are, but its power to script our potentials comes largely from the illusion of total knowledge it facilitates. This is not to say that all knowledge produced by the project is illusory, only that this knowledge is partial and contingent while claims made from it are so often universalized and that the biopower it generates depends on the messianic promise of revealed truth. While neither the representational view of language nor the postmodern view of language as an iterable process of endless translation preclude scientists from making flesh from DNA words and cellular reading systems, only the postmodern view takes into account the full implications of citationality and thereby undermines all claims to linguistic (or genomic) mastery that use of the metaphor otherwise seems to support.

Providing the Substrate: The Challenge of Bioinformatics

As Derrida points out in *Archive Fever*, one cannot conceive of an archive without an archiving institution, without a physical location for the materials, nor without curators of those materials. In the case of the Human Genome Project, the

physical locations of materials are dispersed, ranging from the national laboratories created as part of the Manhattan Project to those of universities and biotechnology companies around the world, as well as within the virtual space of the world wide web. Curators include a vast array of scientists, politicians, administrators, lab assistants, computer programmers, entrepreneurs, and reporters.

As I argued in Chapter 2, the Human Genome Project is a textbook example of what David Harvey identifies in *The Condition of Postmodernity* as the shift to flexible accumulation strategies and increasing technological dynamism that is typical of late capitalism. It began in 1988 as a multi-billion dollar effort to generate genetic, physical, and nucleotide sequence maps of a composite human genome, as well as the genomes of other life forms commonly used in lab experiments, such as mice and yeast. In order to make its ambitious sequencing goals possible, it was also designed to generate new technologies that would automate sequencing. The importance of generating all three types of "maps" lies in the processes and rhetorics that they each enable.

Physical maps are replicated fragments of DNA that have been lined up in order by matching their overlapping ends. They serve as both a "map" and a bank of raw materials. Today, geneticists looking for particular genes or investigating gene function can simply order the cloned DNA segments they are studying from a gene "bank" or gene "library." Physical maps are comparable in many ways to the samples collected by natural historians in their effort to create a taxonomic archive of all living creatures. Like their more immediate predecessor, the seed banks, gene banks are also implicated in colonialist rhetorics of conservation that focus on preserving genetic biodiversity only in terms of its usefulness for pharmaceutical

and chemical (and hence capital) production. I will discuss the issue of biotech colonialism later in this chapter, but first I will address the rhetorical effects generated by genomic research and the archival problems faced by those trying to make genomic information useful for scientists.

Nucleotide sequence maps are what we generally think of as the focus of the project, those strings of A's, G's, C's, and T's that indicate the molecular pattern of DNA. While knowing the pattern of nucleotide sequence in a genome facilitates the image of complete and total genomic knowledge, simple sequence mapping tells us nothing about how genes interact with cellular biochemical processes to produce proteins. Nevertheless, the sequence map is promoted as a kind of road-map that geneticists can use in their investigations of gene function, but as we will see, that is a problematic image for a number of reasons. What this type of map does offer is the illusion of a completed body of knowledge which facilitates the geneticization of biological study, cultural production, and our understanding of the forces that shape environments and societies.

Genetic maps are generated through linkage studies and offer an indication of where the "gene for" a particular disease or trait might be found on a chromosome by tracing its relative frequency of transmission in progeny. The rhetoric of presence in the terms the "gene for" something is, however, misleading, as a "gene for" something generally creates disease by being a gene that does not produce what it should. Rather than the positive presence of a gene that produces a disease, what we often have is an allele of a gene that is silenced in one of a variety of ways that makes it unable to produce what the body needs. Despite the misnomers, however, these maps do offer us some understanding of genomic expression. What they do

not offer is the same image of complete knowledge that the nucleotide sequence map offers.

Press releases on the progress made by the Human Genome Project generally emphasize the virtual completeness of the nucleotide sequence map to claim complete access to the lexicon of life and at the same time emphasize the knowledge of gene function that comes from linkage studies to emphasize the depth of our knowledge of particular genetic pathways. Taken together the impression given is that we are gaining precise knowledge of and eventual control over the entire genome, which is untrue. Although genetic study is making it possible for humans to script molecular documents that alter an organism's biochemical processes, and in doing so also making it possible for biotechnology to alter human economic and social structures, this ability is not based in the kind of complete knowledge that publication of the HGP's sequence map seems to offer.

The sequence map is neither complete, nor fully correct, nor fully understood despite claims that "the complete anatomy of the human genome is now before us" (Peltonen and McKusick 1224). The flesh being written with our fledgling understanding of genetic language is not under the precise control that such rhetoric claims. In fact, as iterable processes, neither linguistic nor genomic meanings can ever be objectivized and controlled with no remainder. Even with two sequence maps that together catalog an estimated 90 percent of the G's, C's, A's and T's in the HGP's composite human genome, we still do not know how many genes there are. Early estimates of 100,000 genes have been reduced to around 32,000, but the gene prediction programs used to make such estimations cannot identify genes in what is called "dark matter." These programs work by looking for

sequence that is "similar to known genes or gene fragments or by homing in on a sequence of the right size that has the telltale beginnings and ends of a gene," but because the comparisons are based on "catalogs of expressed genes known as expressed sequence tags" they are not capable of recognizing many genes that are rarely active (Pennisi 1180). There are also regions of the genome that are particularly difficult to clone and therefore unlikely to be sequenced by current methods.

Still, the flood of information that is being generated by the Human Genome Project presents molecular biologists and computer scientists with many new challenges in their attempts at creating complete archives. From making sure that the sequence map is as accurate as possible to generating software that will provide annotation of known or potential genes, the struggle to gather data for the genetic archives and control its quality has generated the new discipline of bioinformatics. About 2% of the contributions to GenBank are suspected of containing DNA sequence introduced via flawed experimental procedures, such as the failure to remove vector DNA introduced by commercial cloning kits, while many others are missing sequence data when they are labeled as completed sequences and still others are misassembled (Pennisi 448). One of the problems is that many of these archives expect their contributors to update and correct their own sequence entries, but there is no system of rewards to encourage researchers to do so and "many find the task too burdensome" (Pennisi 448). Another is that even when such errors are found, there is often no mechanism for the researcher who found the error to correct it or mark it to keep other researchers from being misled. The genetic archives have what

one researcher has called an "error legacy" whose minimization is one focus of bioinformatics (Pennisi 448).

Errors in the recorded sequence data are not the only way researchers can be misled. While the computer models used to predict the potential functions of gene sequences do so by comparing them to known gene sequences, the "domains" of most proteins can have several functions, so predicting what they do together by simple comparisons is fraught with ambiguity. Annotation is the term used for these descriptions of potential gene function, a term that makes it seem more factual than it is. One computational biologist estimates that "about 15% of the annotation in GenBank is unverified or not up to date" and calls the growth in errors "explosive" (Pennisi 450).

Another problem for bioinformaticists is that more than one protein can be generated from many genes via differences in the way they are "read," and there is no way to deal with these "alternative ways of reading a gene" in current databases (Pennisi 450). It seems that genome annotation is struggling to come to terms with the problem of translation, but it is generally doing so based on an understanding of genomic language as fully available to a single, unified, complete translation. No mechanism is provided for recording the variety of readings that a gene is known to engender (not to mention the readings we will become aware of in future genetic study) since the model for genetic translation is here based on an understanding of language as representational process. And while computational biologist Chris Overton and his colleagues have even developed "a set of annotation tools that use grammar rules and other aspects of computational linguistics to sort out genes and their function," computational linguistics uses a binarist understanding of language

that is amenable to use in computer programs but that lacks the complexity of either natural linguistic or molecular specificity (Pennisi 450).

Nevertheless, biosequence exegesis has become a growth industry, with non-profits and companies competing to generate the most competitive database annotation system. Of course, these annotation systems do not need to be correct or complete for money to be made from them, as they only have to provide what seems to be the most comprehensive and accessible archival system of the moment. Viewing language as an iterable process of stochastic pattern accretion in which any element will have multiple paths of influence could even help bioinformaticists manage the proliferation of data generated by genomic study, but it would not facilitate those claims to full knowledge that are, as Latour argued, nothing more than the grasping of power over others. The postmodern view of language does not, of course, rescue us from all power plays. Rather it brings them into the open as a recognizable part of scientific activity that must be accounted for and thereby can help open scientific activity to the agora. The narratives, pharmaceuticals, medical treatments, and industrial practices that will be developed from these archives will have profound affects on our lives in the age of biotechnology. We must all become more aware of how they will do so and engage in shaping new, more inclusive boundaries for biotechnology that answer to our concerns for a more just world.

"Transgenic Writing" and the Dawning Age of Biotech

The mobilization of linguistic metaphors in researching and commodifying DNA has played a pivotal role in support of the rhetorics of mastery operating in various promotions of transgenic writing. Transgenic writing indicates the manipulation of DNA to produce particularly desired effects in the bodies of a

variety of organisms by altering their DNA sequence using recombinant DNA technologies. While traditional plant and animal breeding techniques are somewhat limited by species boundaries that limit the potential combinatorial arrangements within a gene pool, genetic engineering allows virtually limitless combinatorial arrangements (Nottingham 5). While many recombinations will fail to produce viable organisms, this lack of limitation on what combinations can be attempted still increases the possibility that the introduction of foreign genes into a gene pool may have undesirable effects. Rather than the stochastic accretion of nucleotide segments through evolutionary time, genetic engineering opens the language of DNA to novel recombinations and syntactic shifts in targeted genomes. Additionally, the use of bacterial or viral vectors and the introduction of "a range of other genes, responsible for promoting the correct functioning of the foreign gene, and acting as markers to identify transformed material, are transferred along with the gene for the desired character" and have the potential to generate undesirable characteristics in the transgenic organism and in its wild relatives if cross-fertilization occurs (Nottingham 6).

Not all genetic engineering involves the introduction of foreign genes to a particular genome. Rather, a gene can be silenced by inserting either an antisense (reversed and therefore unreadable) construct of the gene or by inserting a sense gene construct that will likewise block protein synthesis from that gene. How this works to silence the expression of a gene is unknown, but the fact that it works makes it useful for genetic engineers seeking to silence the expression of particular genes (Nottingham 21). Once again, one does not need to understand how iterable systems work to use them, but our mistaken belief that we are in complete control

of their meanings and results simply because we can do things with language generally serves the interests of capitalists. Calgene's FlavrSavr tomato, commissioned by Campbell's Soups, was created by inserting an antisense construct of the gene that codes for polygalacturonase, an enzyme that ripens tomatoes. While the FlavrSavr's extended shelf life was one benefit, the real point of interest for Cambell's Soups was the reduction in water content, which allowed substantial savings in "harvesting, trucking and processing costs" as well as reduced spoilage (Nottingham 65).

Today DNA can be constructed in the laboratory with automated DNA synthesizers capable of combining nucleotides in the order chosen by a human programmer rather than as part of cellular copying functions. Moreover, "sequences for important genes are stored as programmes to allow synthetic genes to be manufactured quickly and easily. The DNA synthesizer can also be used to modify coding sequences to create novel proteins" (Nottingham 16). With this technology we are clearly learning to write with DNA rather than simply to manipulate the materials found in cells, although learning to write with DNA does not mean we know how DNA generates meaning or that we can fully predict the kinds of meanings that these inscriptions will have.

The same could be said about language, as there are many competing explanations for how language carries or generates meaning and of its relationship to the formation and functioning of human consciousness and culture. Our understanding of the semantic relationships that shape the language of DNA remain rudimentary, but as the age of biotech matures we will no doubt come to feel we are gaining proficiency to the point of mastery. We must be careful of such claims as

the potential consequences of rewriting this language of life could be profound. Moreover, the targeting of genomes and the types of modification genetic engineers make in them are directly related to politico-social and capital patterns and the effects of these relationships on our understanding and applications of transgenic writing must be considered.

The first transgenic plant was produced in 1983. The types of crops chosen for genetic modification and the types of modifications made in a particular crop generally reflect the economic importance of that crop. Between 1989 and 1995, "over sixty plant species had been genetically engineered and nearly three thousand field tests of transgenic crops had been conducted worldwide" (Nottingham 6). Most of these genetic modifications were designed to increase a crop's resistance to a particular type of herbicide.

One example that has caught the attention of many is Monsanto's Roundup™ resistant soybeans, maize, canola, oilseed rape, sugar beet, tobacco and cotton. Since the application of herbicides to kill weeds is limited by the amount of damage they can also do to the crop itself, a crop that is engineered with resistance to Monsanto's brand of herbicide provides the company with a remarkable opportunity to capitalize on their patents and their acquisition of, or license agreements with, major seed companies. Monsanto is exemplary of industry trends, as Stephen Nottingham points out in *Eat Your Genes: How genetically modified food is entering our diet* (37). Moreover, although industry representatives often argue that using herbicide resistant crops will reduce environmental damage by reducing the quantity of herbicide sprayed, Nottingham argues that this is not the goal of such research.

> Application of herbicide can now be done in certain crops, with engineered resistance, and under certain circumstances, when spraying was previously not possible. Multinational companies have been applying to have the range of uses of major herbicides officially extended to cover these new opportunities. (43)

Moreover, there are a variety of reasons why what is good for Monsanto may not be good for the rest of us, including the threat of excessive glyphosate use on endangered species, the possibility that glyphosate herbicides reduce soil fertility, that glyphosates are a common cause of poisoning among farm workers, and the potential for increased resistance in weed species eventually requiring the use of even stronger herbicides (Nottingham 44).

Many other genetic modifications in crops are likewise geared to the interests of those with the capital for transgenic writing. Bacterial genes that produce starch have been inserted into potatoes to produce a GM potato with a 20 percent increase in starch content. The value of such potatoes to McDonalds, which uses them for their French fries, is that they take less oil and less energy to fry, hence they cook more quickly and allow for faster production (Nottingham 68). The reduction in fat content is not significant enough to be of any real health benefit to consumers, but their profitability for McDonalds makes this the most common kind of transgenic writing at this stage in the biotech era. Called "Frankenfoods" by their critics, such redesigned plants and animals are intensifying the use of industrial capitalist business practices in agriculture.

As population geneticist Richard Lewontin argues in *The Maturing of Capitalist Agriculture: Farmer as Proletarian*, biotechnology answers a particular need in the drive to capitalize the agricultural process by offering the conglomerate

producers of farm inputs and processors of farm outputs a new way of controlling the production of farm biomass that relegates the farmer to the role of contract labor despite his or her ownership of part of the means of production. This proletarianization of the farmer in capitalist countries has been delayed by both financial and physical qualities of farming, but the agrifood system, which Lewontin distinguishes from farming as the supplier of farm inputs and processor of farm outputs, is currently seeking to increase its control through biotechnology.

> The problem for industrial capital, then, has been to wrest control of the choices from the farmers, forcing them into a farming process that uses a package of inputs of maximum value to the producers of those inputs, and tailoring the nature of farm products to match the demands of a few major producers of farm outputs who have the power to determine the price paid. (75)

Biotechnology can do for the agrifood system what hybridization could only do for a few crops. Lewontin argues that the capitalization of agriculture had reached its structural limit in the 1970s, but that biotechnology now opens many more aspects of farming to control by capitalists. While "the inbred/hybrid method only applies to a few organisms, and the contract system requires threats, monitoring, and litigation to make it work," he argues that biotechnology now offers "the solution to ownership in seed crops" (80).

In March 1998 the Delta and Pine Land Company and the US Department of Agriculture were granted a patent on "a genetic manipulation that would allow plants to set seed and therefore make a crop, but which would render those seeds unable to germinate" (Lewontin 81). Dubbed the "terminator gene," it has also fueled many protests of biotechnology. Protesters are concerned that the pollen of

plants with the "terminator gene" would spread to neighboring fields of the same crop and thereby sterilize the second generation of that crop's seeds, that the effects of the tetracycline application required to produce these transgenic seeds have not been adequately considered, and that the toxin the plants produce to sterilize their seeds might have ill effects on the organisms (including humans) who are their intended consumers. The international outcry has been so strong that many of the patent holders of this and similar "terminator" seed technologies have promised they will never use them, including the US Department of Agriculture and the president of Monsanto (de la Perrière 24-31). How long such promises will hold remains to be seen.

While the major agrifood corporations and the contract farming system both predate the biotechnological revolution, Lewontin argues, it is biotechnology that allows a direct "material linking of inputs and outputs" (82). This technological linkage also makes it possible for western agrifood conglomerates to appropriate key molecular resources from all over the world, often undermining the economic and social stability of other nations. For example, the transgenic canola now being grown in the US that produces a lauric acid that had once only been available as an extract of imported palm oils has left many Phillipine farmers and processors of palm oil without buyers. Scientists have also transferred the genes for the biosynthesis of caffeine into soybeans, and as Lewontin argues, if coffee flavor can likewise be transcribed into a US crop, "Central and South America and Africa will lose their market for beans destined for powdered coffee" (85). These kinds of applications of biotechnology are a kind of molecular level appropriation of resources from other nations, dubbed "biopiracy" by critics like Vandana Shiva.

They have their precedent in the hybrids created from international seed banks in the 1970s.

While hybridization has been promoted as a method of adding value to seeds for the farmer, the corporate rationale for hybridization has always been the increased control it offered the agrifood system, both in terms of protection for their proprietary interest in the seed and for encouraging the use of other farm inputs they supply. As Lewontin pointed out in his 1990 Massey Lectures, published under the title *Biology as Ideology*, "the invention of hybrid corn was . . . a deliberate use of the principles of genetics to create a copy-protected product" (55). He quotes the inventors' own account of their work to illustrate their intentions: "the utilization of the first generation hybrids enables the originator to keep the parental types and give out only the crossed seeds, which are less valuable for continued propagation" (55). Hybrid seeds make farmers more dependent upon seed companies because they do not "breed true" so that seed must be purchased instead of grown on the farm, and the value added to these seeds is generally tied to increasing the farmer's use of agribusiness inputs like fertilizer and pesticide.

Moreover, calling oneself the "originator" of a seed is a bit disingenuous. These inventors neither created the seed's cellular mechanisms nor its nucleic DNA. Their accomplishment in generating hybrid crosses from inbred lines operates via an intense and directed selection from already available varieties. As such hybridization has often been used as a method of patent protection by agribusiness firms to simultaneously deny "third world" claims to the biological resources found within their borders and to generate and protect the company's claim to exclusive ownership of the hybrid seed. While hybridization has already been used as a

method of patent protection to relocate ownership of biochemical resources from the "third world" to primarily US corporations, biotechnology will expand the number and kind of resources available for appropriation by making them accessible at the molecular level.

Vandana Shiva points out in "Biotechnological Development and the Conservation of Biodiversity" that the Latin root for private, *privare*, means "to deprive," indicating that the relationship of the private to the public is one by which materials are removed from the common ownership of a community and guarded as the sole property of an individual or company. This move is inherently a gesture that gives ownership to individuals by taking from the commons, which is also the essential gesture of property in John Locke's *Second Treatise on Government*, which I will discuss in Chapter 5. Colonialist and imperialist trade in biomaterial has often meant dramatic shifts in economic power, and biotechnological appropriation at the molecular level has been no different.

Like the rubber plants smuggled out of Brazil and sent to South East Asia via Kew Gardens, the relocation of such commodity production is again likely to cause the "boom–bust–famine cycles" we should by now recognize as a result of capital's appropriation of such materials from people who depend on their present economies of distribution (Shiva 215). Shiva points out that early explorers of the "New World" were looking for potentially profitable biomass as much as for gold, silver, or slaves: "In the sixteenth century fewer than 100 new plants were introduced into England. Some 1,000 were introduced in the seventeenth century and 9,000 were brought in during the eighteenth century" (215). The first European botanical gardens were established in the seventeenth century, and by the nineteenth

"most colonial powers had such gardens, which effectively helped to channel biodiversity to these countries for their use and even control" (215). These early archives have been succeeded by the seed banks and gene banks of the 20th century, and in the 21st century their function will be taken up be sequence, proteomics, and gene expression databases as well as tissue collections. Like early explorers of the "New World," biotechnology researchers are looking for novel DNA in "third world" plants, animals, and even people that could be used to produce profitable commodities.

More than 60,000 genetically engineered animals were born in the UK alone in 1996, most of which were produced for biomedical research. In addition to laboratory animals with a genetic predisposition to disease, "transgenic cows, goats and sheep have been engineered to produce human proteins in their milk" (Nottingham 8-9). Even livestock are being genetically engineered with "faster growth rates, lower fat levels and increased disease resistance" and research is currently being done to "produce pigs and poultry that are more docile and therefore better suited to intensive rearing units" (Nottingham 9). These animals and plants are all being engineered to meet the demands of large scale commercial food and pharmaceutical production. What they are ultimately designed to produce is profit, with DNA serving as the entry point for these Taylorist farmers of the future. In this growing menagerie of transgenic animals and plants, our industrial food and pharmaceutical production practices combine with genetic manipulation to produce increased stress on livestock and crops as well as potential hazards for ourselves. Moreover, since the data used to evaluate such products is generated by

the company producing the product and proprietary restrictions frequently prevent its full review, we are left with severely limited oversight capability.

While such biotechnologies often promise to bring the Second Green Revolution, we must remember that the results of the First Green Revolution were not always positive. In that first agricultural revolution, hybrid seeds and the heavy use of fertilizers brought an initially dramatic increase in crop yields (from about 1950-1984) and was once thought of as the solution to hunger in the "Third World." After 1984 crop yields "leveled off, or even declined, and it was realized that yield increases came at a price. The high-yeilding crops of the Green Revolution required high inputs of agrochemicals, particularly fertilizer [and water], to achieve their potential yields, and were therefore more expensive to grow" (Nottingham 4). The costs of the first Green Revolution included degradation of the environment, pollution of the water, the reduction of biodiversity via monocultural farm practices, and the displacement of poor farmers.

Many of the same political and economic factors that led to the problems of the first Green Revolution are affecting the Green Genes Revolution today. Most genetically altered crops are designed to meet the needs of industrialized farming practices with little concern for the relationship between high-yeilds and necessary high-inputs. The problems related to the use of rBST in dairy cattle are rooted in this same failure to consider the full consequences of increased yields. A number of companies have developed rBST products that increase milk yields, but they also increase the quantity of feed these cows must consume and the risk of mastitis, and hence the need for antibiotics as well. Early studies by Monsanto claimed that use of rBST did not increase the rates of mastitis, but their conclusions were

contradicted when independent researchers reanalyzed their data and found a significant increase by looking at all of the data rather than only the results from the early weeks of the rBST trials. Moreover, milk from rBST treated cows has been shown to have a higher fat content, among other compositional differences, which indicates that increased yield is not the only change being affected in the milk when rBST is used. Nonetheless, the FDA allowed milk from the experimental trials conducted by Monsanto, Dow Elanco, American Cyanamid and Upjohn onto the market unlabeled in 1986, prior to the corporate research data being made available for scrutiny by independent researchers (Nottingham 29-31).

These are not, however, the only results of transgenic writing, and GMO's can offer opportunities for improved nutrition and medicines for many. From bananas that grow the hepatitis B vaccine, to rice that provides vitamin A, to human insulin produced by bacteria, many GM products do offer significant benefits with limited risks, and transgenic writing is clearly capable of providing opportunities for improved human health as well as potential problems. The common view among genetic engineers is that their work is a type of writing, one that requires the careful recombination of biochemical words and motifs to produce the message of a living organism. Many also view themselves as architects who are learning to read nature's blueprint for life and learning to revise the plans and build the structure differently, with different goals in mind.

In learning to read DNA scientists have already had to learn to write with DNA, to move the signs around in experimental trials to test their effects on organismic function, so further alterations through such processes of reinscription seem like a simple extension of natural processes and of knowledge already gained

rather than truly new territory. Genetic engineers rarely think of their work as manipulation of some pure state found in nature. Rather, they argue that everything they have learned to do is already part of the natural functioning of organic processes, and that man has been directing such processes through agricultural and animal husbandry practices for a very long time. The only differences, they argue, lie in the increased speed of change, the increased quantity of material genetic forces they have access to, and the increased control offered by these new biotechnological processes.

Alan McHughen encourages acceptance of some types of genetic modification in food and medicinal products and is against others in *Pandora's Picnic Basket: The potential and hazards of genetically modified foods*, which he presents as a guide for non-scientists seeking to understand the potential impacts of biotechnology. He is himself a genetic engineer and one of the key developers of three varieties of genetically altered linseed flax. Like Donna Haraway, he is frustrated with both opponents and proponents of biotechnology who fail to generate meaningful debate on the real issues as he sees them, faulting sensationalist media and irresponsible extremists for generating or perpetuating erroneous reports and the biotech industry itself for offering misleading information to both the public and regulatory officials. Moreover, he faults many regulatory processes as being too closely tied to industry interests, which makes them "seem" less trustworthy and undermines public confidence. As a genetic engineer, McHughen would like to influence public opinion toward acceptance of those biotechnology products and processes that in his mind offer benefits without undue risk, which for him can only

be determined in relation to the comparable benefits and risks associated with similar products already on the market.

Despite his attempt at a balanced approach, McHughen's argument and many others like it are grounded on the assumption that science offers the only method of judging such benefit and risk calculations and that social or ethical concerns are only applicable after an unquestionably solid scientific process produces the facts on which decisions can be based. He states: "With the scientific and factual basis, you may then incorporate the other aspects to build your position, confident in a stable and solid foundation" (10). Moreover, he describes technological processes as the contents of a Pandora's box, arguing that one cannot successfully ban a technology once it is created because "sooner or later, someone somewhere inevitably, perhaps covertly, practices the craft" (8). Hence we are left powerless to stop the transgenic inscriptions being drafted in laboratories all over the world and our only source of legitimate resistance is to come from within scientific discourse in response to the ways these inscriptions alter our world. His position ultimately precludes any intervention on behalf of social or ethical considerations prior to the creation of the biotechnological product or process.

McHughen does not feel this is a handicap for those who would resist these transgenic reinscriptions since he views science as an open system in which "neither side has a monopoly" (4). In many ways, his vision of the openness of science is like Lyotard's. There are at least two obvious problems with reliance on the openness of science for determinations of what kinds of transgenic writing our social institutions (including patent law) should and should not facilitate. First, the production of scientific facts requires large capital investments, so the discourse of

scientific fact production is inevitably tied to the interests of those with the capital to invest. Moreover, proprietary restrictions often limit the access that outside scientists need to evaluate company claims. Second, as McHughen's own Kuhnian disclaimer indicates, new data may force him to change his position on a particular GMO's relative benefits and risks (5). Scientific facts are always subject to challenge from within scientific discourse as they only represent the conclusions drawn from the available research done at any particular point in time. There are always new questions to be asked, new circumstances to be considered, new methods and technologies of analysis, new knowledge about chemical and metabolic processes, etc. that can undermine what was once viewed as a firm scientific foundation.

While McHughen and Lyotard see this as the source of openness in scientific discourse, what it more often produces is the spectral messianicity Jacques Derrida discusses in *Archive Fever*. It offers the promise of the deferred availability of the truth, the promise that the full effects of the introduction of a GMO product or process are both discoverable and manageable. Appeals to the openness of scientific discourse offer the illusion of security in their deference to an essentialist vision of the truth and faith in its inevitable appearance via scientific study, but we remain in the middle of the detective story and cannot arrive at its end. The denouement is perpetually deferred.

McHughen's text, however, can offer its readers a rather different education than what its author explicitly intends as he illustrates that scientific fact generation is ultimately unable to secure the rational discussion and evaluation of GMO's that he desires because it is unable to provide the clear and unambiguous foundation for

such discussions. Although he argues that one must base any decisions about the rules governing GMO release on a firm scientific foundation, he also argues that science cannot offer proof that a GMO is safe: "It is not scientifically valid to say 'I have proved there is no risk associated with this product'. It could well be, and often is, a politically valid or legally valid statement, but it is not valid in the realm of science" (20). Since science cannot provide proof of safety because it can never anticipate nor evaluate every potential variable in the stream of effects a particular GMO might generate, it cannot offer the absolute of a "solid foundation" for such discussions. Science is a process, not a product, and it operates within, not beyond, the political realm–its "solidity" the result of the rhetoric of transparent translation it invokes. Its truth is found only in the messianic promise of revelation it offers, not in any single accretion of "scientific fact" from the then current milieu. It is always already a part of political and legal discourses that use its messianic properties to justify their own arguments.

McHughen's excessive faith in the ability of science to discover Truth (rather than produce truths) relies on a simplistic understanding of genetic language's power to communicate clearly, and hence to be known, to be mastered. He describes DNA as a "universal language" in which there is "no ambiguity" and argues that while many describe DNA metaphorically as a language, for him DNA is "actually a real language in that it is truly a medium of communication" (20). While McHughen views DNA as a semiotic system, and as the "universal language" of living organisms, he also knows it as a physical entity, a material that can be manipulated to produce desired affects. Geneticists learning to speak this language must deal with the fact that "DNA is not a blueprint; it is a physical entity. It can

and does break when, for example, it is pushed too forcefully through the narrow bore of a syringe held by a trembling novice technician" (21).

Language can certainly be viewed in the same way as a material entity that, when pushed too far ceases to make the connections among humans and non-humans that it must make for communication to occur. Anyone who has ever graded freshman compositions has certainly seen such breaks in the material use of language. Poets, politicians, lawyers and advertisers exploit the material nature of language to create particular effects. Semiotic processes are clearly more than simply systems for communication, although that is one of their functions. Likewise, DNA does far more than serve as the stable medium of communication between generations and through an organism's development.

Pharming the Archives: The Archive as Pharmakon

Evelyn Fox Keller has described science as a process that produces efficacious knowledges rather than truth. By efficacy she means both a definition of knowledge that has the material force of truth because it can command material forces, and one that acknowledges the role of politics in the creation and institutionalization of such truth effects. While science generally facilitates the archivization of itself and its others in a corporealization that legitimizes the power of those who control the archives, viewing the corporealization of DNA and our increasing penchant for transgenic writing as an efficacious archival process that is always already engaged in negotiating positions within the systems of difference of which we are a part will help us recognize the role of the political within science and acknowledge the right of everyone to speak to these interventions in their lives.

Rather than view science idealistically as a pathway to truth while claiming that ethical standards for its application must come from some other domain, this understanding of science places questions about ethics and value choices in the foreground by recognizing that it is not only, nor even primarily, the goal of molecular biology, for example, simply to understand biological systems. Rather, biologic study is always already engaged in a discourse and practice of intervention, and the linguistic metaphors used in the research and enculturation of DNA reflect the goals of that discourse and those practices of intervention while at the same time they offer avenues for critical analysis. In the age of biotechnology we all need to examine how these interventions will reshape not only genomes, but cultures, economies, historical narratives, and medicinal practices. What are we expecting to achieve via the Human Genome Project and the transgenic writing it will facilitate? Science articles on what to expect from HGP research focus on the integration of current knowledge about DNA with the disciplines of history, sociology, psychology, biochemistry, patent law, medicine, agrinomics, toxicology, and many others.

Researchers are looking into how genetic differences among individuals shape their response to environmental toxins and pharmaceuticals. In doing so gene variants, called alleles, that do not facilitate the metabolization of particular toxins or drugs as other alleles of that same gene do are called "mutants" even when metabolization of the toxin or drug is not commonly demanded by the organism's environment. This language reflects the common use of "wild-type" or "normal" to indicate any allele that can be used to produce a protein and "mutant" for any allele that fails to produce the necessary protein (Evans and Relling 488). Unfortunately,

this equation of efficacy with normality and inefficacy with mutancy and abnormality sets up a rhetorical dynamic whereby individuals who are perfectly healthy yet carry "mutant" alleles for the metabolism of particular toxins or drugs that are *not* generally part of the human environment may be treated as if they are deficient and their "genomic endowment" is the cause of their health risk.

Identified "environmental susceptibility" genes or gene combinations include those for "asthma, diabetes, lead poisoning, and a lung disease caused by the metal beryllium" (Kaiser 1207). Industries that expose workers to toxins and drug companies studying the side-effects of their products could simply exclude persons who are sensitive to these chemicals from employment or clinical trials. While toxicogenomic and pharmacogenomic studies could help patients by enabling doctors and pharmacists to tailor drug treatment regimens to the needs of individual patients, it could also artificially improve the safety calculations for drugs as well as allow businesses to continue environmentally dangerous practices by hiring only workers who could metabolize the toxins in their workplace.

The term "genomics" first appeared in a speech given in August of 1994 by George Poste, then president of research and development at SmithKline Beecham Pharmaceuticals. He defined it as "the study of genes and their functional regulation in health and disease," but it has increasingly and more accurately been used in *Science* to indicate the potential economic benefits of genetic research and the struggles over patents and database information that this research has generated. "Genomy" was the term used prior to this speech, but it quickly lost ground to "genomics" judging by the relative frequency of use in *Science* and *Nature*. This change in terminology reflects the confluence of interests surrounding the

production of knowledge about the genome. Choosing "genomics" instead of "genology" or "genomy" reflects the connection between the production of knowledge and the production of capital. Similarly, "biology" is "the study of structure, functioning, growth, origin, evolution, and distribution of living organisms," while "bionomics" is another term for "ecology" that portrays the natural world as a marketplace in which different organisms vie for position (Morris 133).

Had Poste chosen the suffix "-logy," meaning "the study of" (from the Greek *logos*, meaning word or speech and implies naming) (767), or the suffix "-nomy" (which comes from either the Greek for managing (*nemein*) or for the law (*nomos*) and means "the systematization of knowledge about, or laws governing, a specified field") (892), he would have been using a word that more thoroughly hid the connection between the generation of capital and the generation of scientific knowledge. To use "-ics" implies the application of knowledge as part of a managed capitalist marketplace, rather than simply the collection and analysis of information.

Furthermore, Poste's speech promotes a vision of the future in which a "molecular medicine" will move us from the current "reliance on treatment towards a greater emphasis on disease prediction and prevention." He argues that this new paradigm for medicine will approach "human health from the viewpoint of 'total disease management'" and will "create significant opportunities for cost-containment in healthcare delivery" (166). As Donna Haraway and others have illustrated, this notion of systems management has become the paradigm for most medical knowledge today and the motivating spirit behind its decisions is the

rational control of the marketplace, often enough at the expense of patient care. The likelihood that the simple presence or absence of a gene identified as the cause of a pathology will mark individuals as ill before the onset of clinical symptoms ignores what we already know about the complex interactivity of genes. This interactivity "results in marked variations in the symptoms of patients with the same diseases," and yet, "of the 1500 or so monogenic diseases for which the mutated gene has been identified, there are only a few where the effects of other genes on disease pathogenesis have been studied" (Peltonen and McKusick 1226).

One of the primary interests in mapping the human genome is to locate genes essential in the creation of medically relevant (read patentable) proteins and enzymes. Likewise, the primary interest in mapping the genomes of various animals derives from their kinship with us, as their genomes are used to narrate evolutionary tales, to help locate specific genes in the human genome, and to serve as factories for the production of human body parts at the molecular level. Moreover, the flow of lucrative biomass is generally from poor southern nations to the pharmaceutical and biotechnological industries of rich northern countries.

For example, in the mid-1980s a medical anthropologist doing research on the increasingly poor health prospects of the Hagahai people of Papua New Guinea took blood samples from approximately 25 individuals in an expedition funded by the US National Geographic Society. Although her research report calls for improving the health prospects of the Hagahai through the "modernization of their biology and culture," what her research enabled was the patenting of an immortalized cell line from this genetically isolated group. This cell line offered a benign version of a T-cell leukemia lymphoma virus (HTLV-1) that was patented

by the US government in 1995. Although it does not seem that the anthropologist who took the samples originally engaged in this research with the intent of scanning the Hagahai genome for profitable commodities, she is listed on the patent (Cunningham 209-10). The "first world's" penchant for patenting genetic material and chemicals found in the "third world" without recompense now extends to samples taken from human subjects. The profits to be made from cell lines and tissue cultures are enormous. In 1996 alone it is estimated that $427.6 million were made from the sale or licensing of such biological materials (Cunningham 217). When even humans themselves, frequently without their full knowledge or consent, have been treated as resources for the creation of patentable cell lines in medicine's search for cures and profit, clearly we must examine the values put forward by such efforts.

More overt examples of genome prospecting among humans are also available. For example, the case of the "The Great Human Expedition" in Columbia, which received funding from both public institutions and biotechnology companies. The Genetics Institute of the University of Javeriana, Bogota worked together with geneticists from the Hoffman-LaRoche pharmaceutical company to collect blood samples from several indigenous groups in Columbia. While such blood samples are serving as the raw material from which genetic gold is mined, the researchers were caught on film telling members of the Asario Indian tribe that the samples were being taken only to test them for diabetes (Cunningham 216).

This is hardly the only instance where medical diagnosis and treatment of an individual is used as the cover for biotechnological prospecting, and not all such prospecting occurs among indigenous populations. In the mid-1970s an American,

Thomas Moore, was treated for a rare form of leukemia at UCLA. His doctors chose a course of treatment that generated a valuable cell-line which they then patented and sold to a biotechnology company. When Moore found out that his medical care had been, at least in part, planned with these ulterior motives in mind without his knowledge or consent, he sued. The California Supreme Court ruled that once biological materials are taken from a patient's body they are no longer the patient's property, however, full informed consent should be given and the patient's privacy protected. The case never went on to the US Supreme Court because the parties settled after the California ruling, so there is no nationally valid tort on this issue. Judging from the actions of the few states that have enacted legislation concerning the privacy of patient genetic information and the ownership of biomaterials removed from patients during treatment, however, the ruling is consistent with prevailing sentiment.

In light of this prospecting, archival projects such as the Human Genome Diversity Project become highly suspect. While not part of the original Human Genome Project, its goals and methods are consistent with the rhetoric of the HGP and it will provide the tissue samples necessary for the comparative genomics that some genome centers would like to pursue in the future. It is also likely to offer unique alleles that could be the raw material for generating new medicines. The HGDP is designed to collect and study blood and tissue samples from 722 indigenous populations that are threatened with assimilation or extinction from the effects of the very colonialization reflected in the design of this latest effort at the same type of natural history that helped European nations plunder the resources of the "new world" in previous centuries. Like the taxinomic studies of that earlier

archival effort, the HGDP would catalog "which sequence variations occur at each site in each population, and how prevalent each one is [which] can be used to infer degrees of relatedness and construct genealogical trees" (Kahn 720). Moreover, it includes plans to develop technologies that would allow scientists to salvage DNA from older collections, such as "Weiss's 30-year-old samples from 12,000 individuals in the Amazon region" (720). Since these individuals likely cannot be found, and hence cannot consent to or protest the uses to which their DNA will be put, archives such as this one have become hot commodities. Trade in biomedical archives among universities, biotechnology and pharmaceutical companies has presented ethical challenges within the US as well.

This "pharming" of the biomass does not, however, produce only the information and products intended by biotechnology companies. It also produces resistance to global capital via the growing global coalitions that challenge the views implicit in the relationships cemented by genetic archivization as currently practiced. Dubbed the "vampire project" by critics, the HGDP's concern for collecting samples from threatened human populations before their assimilation or extinction fueled protests by resistance organizations such as the Rural Advancement Foundation International (RAFI) and the World Council on Indigenous Peoples (WCIP).

Many countries remember the results of an earlier archival project for seeds and compare its results to the likely results of the HGDP: The International Board for Plant Genetic Resources had "developing countries contribut[ing] enthusiastically [in the 1970s] to an effort that produced a public-domain collection of 125,000 plant germplasm specimens" (Kahn 721). Despite the public nature of

the archive, western patent law allowed "multinational seed companies [to use] some of the strains to produce hybrids, which they then patented–with no share of the profits going back to the developing world" (721-2). In fact, resistance organizations have focused their efforts on influencing international patent law and regional trade agreements because it is clear that these are the muscle flexed by those who would prospect among indigenous peoples. In the case of the HGDP, protests virtually shut the project down until organizers revamped it in answer to their criticisms. While some will now join the project, others will not.

These are all archives in contention–nodes of durable action where the archons, which can and should include the public at large, both read and write the meaning of the archive in the ongoing co-production of archives, archons, and publics. Are these technologies the cure for hunger and disease or do they create economies that cause hunger and disease? What is being "pharmed" from these archives, cures or poisons? Does it make any sense to ask that question in that way? It seems that always depends on who you ask.

As the list of transgenic animals, plants, and bacteria grows, their proposed role in providing twenty-first century cures for the illnesses of individuals, groups, or environments begs the question of their position as pharmakon. The affects of biotechnological products and processes on individuals and economies present a complexly woven fabric of benefits and dangers which cannot be determined in advance. While many of the targeted groups resisted the HGDP, "the Euchees and Apaches of Oklahoma have decided to take part" precisely because they "have an unusual tolerance to blood sugar" (722). Since almost all human genome research has been done using samples from Caucasian donors, many want to avoid being left

out of the medical knowledge base so that future medical treatment options will be as available to them as to Caucasians. Similarly, the historically low success rates for organ transplants among African Americans are "largely due to a higher error rate when tissue-typing" which could be alleviated by a larger knowledge base (Kahn 721).

The history of imperialism and colonialization clearly resonate through these archival projects for DNA, and deciding whether to take part in such a project is difficult. There are potential benefits for some and only continued use as the raw material for capitalization for others. Moreover, not knowing what might be found within one's own genome now or at some time in the future and not being able to control the kinds of messages and products that are drawn from it makes the decision to include yourself and your family in the search for genetic information and novel proteins simply an exercise in trust or suspicious avoidance. There is no way to know what this archivization, or any archivization, will bring, because it is an ongoing process of negotiation among genomes, technologies, humans, and human institutions. As an event in the ongoing process of becoming that never arrives at an end, genomic archival and the powers that it enables are the way that we engage with our others. They are technologies of inscription through which our relations with the world and each other are negotiated. As such it is paramount that we are all able to participate in shaping what is drawn from the archives.

Semiology: The Problematics of Diagnosis and Cure

Semiology is not about total knowledge of the full set of linguistic performances. Rather, it is a study of particular signs that are perceived as symptoms of an illness in need of a cure. From its first use by John Locke in *An*

Essay Concerning Human Understanding in 1690 it has connected "the doctrine of signs" with the diagnosis of symptoms (Tobin 180). Robert D. Tobin reviews the connection between semiotics and medicine in *Prescriptions: The Semiotics of Medicine and Literature*:

> Like the word pharmakon, a medical term used to describe language, semiotics has, since its earliest attestations down to the present day, had a specific meaning within the technical language of medicine as well as a general meaning in rhetoric. Specifically, semiotics is the medical term for the study of symptoms. Indeed, Locke, who studied and practiced medicine, drew upon medical vocabulary when he introduced the word semiotics to philosophy in his Essay. (Tobin 180)

Tobin reviews the history of the term to illustrate its primary early use was in the medical arena, where it meant the study of the signs or symptoms of disease, before it became an important term for rhetoricians. Based on the work of Foucault and Barthes, Tobin further argues that the epistemological shift from the view that the symptoms of disease were a simple fact to the view that symptoms were signs that had to be deciphered according to current medical narratives made the physician an interpreter of signs who tells stories. Tobin says, "Medicine relies on etiologies, grand narratives, to talk about the beginnings and ends of sickness, the causes and cures, the enabling conditions, and the subsequent ramifications of illness" (Tobin 182).

These are fundamental problems of knowledge and of politics because they are about creating and controlling archives. Scientific knowledge is produced using archivable technologies of iterability to translate the world into discourse and thereby facilitate our manipulation of it and each other through claims of authority

based on the spectral promise of a perpetually deferred complete understanding. What we find when we examine the process of scientific truth making is that scientific knowledge is a kind of medicine, a process of reading signs and narrating stories. It is used to diagnose physical and social ills and to propose and develop technological solutions to them. Other semiologies, other ways of reading the signs of physical and social ills suggest other kinds of solutions. The politics of this medical management should be foregrounded and we should all be involved in the negotiation of systems of difference that these semiologies generate.

CHAPTER 5
ITERABILITY, JUSTICE, AND THE HUMAN CORPUS: GENOMICS CONFRONTS THE LAW

Patents and copyrights approach, nearer than any other class of cases belonging to forensic discussions, to what may be called the metaphysics of the law, where the distinctions are, or at least may be, very subtile and refined, and, sometimes, almost evanescent – Justice Joseph Story, *Folsom v. Marsh* (1841)

[Species] boundaries disappear when the right to manipulate and own life is claimed, but reappear when risks and responsibilities have to be met. This ontological shift is part of the politics of biotechnology in which the circle of rights is expanding and the domain of responsibility is shrinking – Vandana Shiva *Biopolitics*

Increasingly today the courts are asked to pass judgment on cases in which the boundaries of the juridical subject's embodiment, as well as that subject's rights and responsibilities, are challenged by biotechnology. In Tennessee a divorced couple battle over custody of their frozen embryos; in California a leukemia patient discovers that his own physician has used his blood and spleen to generate a very valuable patent protected product without his knowledge or consent and sues to recover a share of the profits; and in many states U. S. Marines and Air Force officers protest the collection of DNA samples for the military's DNA data bank.

All of these cases challenge the court by presenting situations unforeseen by existing laws or legal precedents. They all present the courts with challenges to the agreed upon boundaries of the juridical subject by confronting it with hybridizations on the knife edge where distinctions between self and other, proper and improper, property and commons, liberty and coercion must be sharpened to meet the requirements of modern liberal institutions.

In this chapter I will examine how these challenges might be addressed via a revision of our notion of justice from its current dependence on a philosophical commitment to the free moral agency of a liberal humanist subject to a posthumanist recognition of distributed agency. To do so I will first compare the ways that science and jurisprudence establish such boundaries through processes of bearing witness to show, as Latour has also pointed out, that these boundaries are established in order to both allow for and to deny the relevance of the hybrids they produce, including those produced by transgenic writing practices. I will then trace the history of copyright and property law to examine current debates over the legal status of genetic information and material.

The questions of privacy, property, and justice pervade the emerging relationships among genes, people, nations, corporations, and other organisms. Genetic information is never only one's own in that reading it always implicates others. And yet, genetic information is so much one's own as to be conflated with the self itself in the rhetoric of determinists. Today the genetic is in a similar rhetorical position to that of creative works during the eighteenth century. While the general public and the court system recognize the right of individuals to control access to their genetic material as a question of privacy, they are reticent to

acknowledge property rights to human sources of genetic materials. National interests and global economies are involved in each case. If the history of copyright is a useful guide, as I suggest, we might expect such a discourse focused on the right to control one's genetic signature to lead to a property right in one's genetic material.

Two alternatives to this extension of property relations (one could argue in the absence of truly proper relations) are the status quo with all its recognized problems and the posthumanist revision of our definitions of justice and subjectivity that I will sketch at the end of this chapter. Rather than turn to property law to protect individuals against the coercive powers of the state and of global capital, this approach seeks to undermine global capital's claims for the patentability of organisms by challenging the liberal humanist basis for patents as rewards for individual originality. Even biotech patent holders acknowledge that "hundreds of people beyond those finally listed as inventors" make the research projects that result in patentable products and processes possible.

> Beyond the major research centers lie countless hospitals and clinical services and hundreds of family members who contributed blood and tissue samples and clinical information. Those who crossed the finish lines in these gene races would be the first to acknowledge the complexity of the task and the futility of trying to recognize all those who contributed. But the patent system is a "winner take all" reward system, vesting all rights in those listed as inventors or those to whom they assign their rights. (Cook-Deegan 169)

While many would argue that it would be futile to try and account for all who contribute, surely a reinvigoration of the commons and a shift in patent law that would support the goals of those who contribute is possible.

One interesting example of just such an aggregate benefit calculus is the agreement between patent holders for the "diagnostic or screening use of apolipoprotein E testing" for Alzheimer's disease and the Alzheimer's Disease and Related Disorders Association, whereby a percentage "of any royalties they receive from their license to Athena Pharmaceuticals will [fund their] and other nonprofit research support groups" focusing on this disease (Cook-Deegan 179). One could use similar means to focus revenue streams from the use of DNA samples into new research according to donor's interests.

Of course, the terms of such agreements must be public so that all interested parties can determine whether they are just. Confidential agreements like the one RAFI made public between Searle pharmaceuticals, a division of Monsanto, and Washington University gives $15,000 annually for five years to the local inhabitants for collection of Peruvian medicinal plants. Whether this is enough compensation for the collection of medicinal plants and local knowledge of their properties (since they would not be known to Searle as medicinal plants without using the knowledge of local medicinal practices) cannot be fairly addressed when such agreements remain confidential and only include western companies and universities as parties to the contract.

Indigenous groups have "called for a global moratorium on any further commercialization of traditional plants, medicines and human genetic materials until appropriate meachanisms [could] be developed" to protect their interests (Mackenzie 145). Signed by over 800 indigenous groups, the Mataatua Declaration also calls for a "standardised code of ethics and research agreements" and criticizes western property laws for failing to provide them with adequate protection (145).

The goal should be to increase the opportunities for the performance of justice by recognizing the consequences of distributed agency and to allow for a reinvigoration in the legal standing of the commons. This is a commons that would have to be defined globaly, as genetic research and the profiteering of global capital are not limited to the borders of nation states. If we cannot find a solution that reinvigorates the commons without recourse to the extension of property relations, however, I will also argue that the extension of property claims to one's own cells and genes is preferable to allowing the untenable rhetorical split between "source" of raw material and "originator" of patentable inventions that has so frequently served the interests of the few at the expense of the many.

Bearing Witness to the Birth of Modernity

Contrary to claims in the U. S. Constitution, it is precisely because distinctions between self and other, proper and improper, property and commons, liberty and coercion are not self-evident that they must be created and enforced by the contractual performance of the law. Such boundaries are not established via a revelation of the true and essential identity of the subject. Rather, honing these distinctions requires a process of "witnessing" or "testifying" to establish the facts of the case before the court and to define the issues the court must consider in adjudicating particular border disputes. This process also establishes what is considered acceptable within the domains of knowledge the courts must draw from in sharpening such boundaries.

For scientists, the court's method of establishing fact by taking the testimony of witnesses produces "court decisions that oftentimes appear to ignore or distort scientific principles" (Ferguson 21). And yet, by basing judgments on the

testimony before the court, or testimony before congress in the legislative process, the law has more in common with the making of scientific knowledge than is generally assumed. Both scientists and non-scientists generally view the facts generated by the experimental method as objective, yet when science is drawn into the adversarial structure of the courtroom, the adversarial structure of fact generation in science is also made apparent. Our courts are replete with dueling "expert witnesses" whose testimony often illustrates the pliability of "objective" information and the role of perspective and belief in the production of scientific fact. While scientific "proof" and legal "proof" seem to offer two very different definitions of what may count as knowledge, they both establish facts through a process of bearing witness according to the rules of a particular discourse community.

Again, as Lyotard argues in *The Postmodern Condition*, while scientific discourse seems to "speak the truth about the referent" in a statement that can be verified by others (24), scientific knowledge is constructed according to "the relevant criteria . . . accepted in the social circle of the legitimating interlocutors" (19). Hence, scientific knowledge is judged via the institutional constraints which "function to filter discursive potentials . . . [and] privilege certain classes of statements" (17). As Lyotard points out, science privileges the denotative statement based on information generated through the experimental method, a process by which Nature is supposed to reveal itself, and views narrative forms of knowledge as "less rigorous, 'primitive', and merely matters of custom" (27). Scientific discourse is not, however, wholly separate in kind from legal discourse since both are concerned with establishing what is true, and both depend on

philosophical narratives for their legitimation. The guarantor of truth is, for both disciplines, their supposed access to an objective reality that they argue can be determined via their different processes of bearing witness. While myths of objective witnessing are active in both disciplines, most people believe in the objectivity of science more than they do the impartiality of judges and juries. Even the laws governing the provision of a fair venue for a trial and for excluding potentially biased citizens from the pool of jurors recognize that establishing the mechanism for a "fair" trial is difficult, and appeals processes are designed to address such concerns.

Moreover, this concern with establishing truth is related to questions of justice in both disciplines because it affects the material social relations of humans and nonhumans. Common law is explicitly about the determination of social relations despite myths of jussive impartiality. As Moe Litman argues in *The Legal Status of Genetic Material*:

> Legal taxonomy is purposive. Objects are treated as property, for example, not because they have some intrinsic or objectively measurable characteristic that identifies them as property, but rather because labeling them as property, and thereby subjecting them to property law, best effectuates a broad range of social, philosophical, psychological, and economic goals. Accordingly, legal classification is the antithesis of a technical or objective exercise. It is a normative process. It is rooted in value judgments and entails making fundamental policy choices. (17)

Scientific taxonomies, on the other hand, are generally thought to be a process of naming that seeks to bring the material world into discourse, such as with Latour's pedocomparator and the pedologist's determinations of where the soil samples fit

on the "clay-sand axis." Technologies of inscription, like the pedocomparator, that do the very real work of translation are, however, often made transparent in rhetoric that would have science speak directly about objective reality. Science's role in socializing nonhumans and its affects on the material relations of humans and nonhumans is then viewed as peripheral to its search for facts.

The law, as another technology of inscription that creates and maintains the relations among bodies recognized as juridical subjects, is explicit about its role as an arbiter of just relations. Legislative law is generally recognized as being coterminus with politics precisely because it is about negotiating a balance of interests among social actors (both humans and their others) in the determination of justice and because it is created within the political sphere. Common law, as the application of legislative and tort law is likewise generally recognized as being coterminus with politics. The mythos of a blind justice balancing scales loaded with evidence to determine truth, and thereby justice, is an idealization of what we hope to achieve through legislative and legal processes rather than the assumed outcome of these processes. Science, on the other hand, is generally about socializing nonhumans into the human collective, and that process of socialization is not often thought of as a political process because we do not generally acknowledge the agency of nonhumans.

Acknowledging the agency of things in forming the human and nonhuman networks that co-produce us and our world is one of Latour's main points, although he does not take into account the full consequences for science and society that follow from such a recognition. And yet, the difficulty Latour has had acknowledging the role of the pedocomparator is indicative of the difficulty we all

have when trying to explain the sources of efficacious knowledge while their movements and concretions are so slippery that we can never be completely sure who or what is speaking when science speaks. It is my hope that looking at scientific activity, language, DNA, archives and the laws that flow from them as various technologies of inscription will help us negotiate that difficulty.

Both Haraway and Latour have examined how the voice of Nature is ventriloquized through scientific experiment in what amounts to an automation of the grounding philosophy of science. Indeed, many science studies scholars have shown how the process of experimental fact production is dependent upon its own process of a witnessing that must be held under erasure to make the facts seem objective. From Steven Shapin's and Simon Schaffer's work on the birth of the experimental method, Haraway argues that scientific information takes on the form of truth via the scientist's certification of the products of an experimental apparatus. As Haraway argues in *Modest_Witness@Second_Millennium. FemaleMan©_Meets_ OncoMouse*™, Robert Boyle's inaugural generation of scientific fact depended not only on the construction of the air-pump, but also on his "testimony" to the scientific results via publication and his outline for acceptable experimental method.

Haraway describes Boyle's trinity of material apparatus, advertisement, and disciplinary method as the "founding gesture of modernity" (24). By constructing the material apparatus and bearing witness to its actions, Boyle makes it seem as though Nature is writing itself. By advertising the results of Nature's signature within a rhetorical structure that seemed "unadorned, factual, and compelling," Boyle seemed to take the "modest" position of a disinterested observer simply

recording Nature's inscription of the truth (26). And by establishing the guidelines for the experimental method, Boyle established a powerful discourse community. These three mechanisms are the technologies of inscription which allowed Boyle to generate truth effects through the experimental method that seemed compellingly divorced from human intervention. The mechanism seemed to remove personal bias and human frailty from the equation so that Nature's voice could finally be heard.

What Haraway and other science studies scholars have illustrated is that Nature's voice is still ventriloquized in this process. It cannot be otherwise since Nature does not, in fact, speak without the technologies that humans create to socialize the natural world. While the experimental method is an attempt at automating the discovery of truth via a cyborgization of philosophy, the mechanism, as a product of human thought, material relationships and social and legal structures, is involved in the human political realm that science seeks to escape. I do not mean to claim that the nonhumans socialized via scientific technologies of inscription are unable to affect their inscriptions. In essence they do act as one of the many speakers in scientific fact production, so perhaps "ventriloquized" is the wrong term for what science does in generating Nature's voice. While these nonhumans are made to speak via scientific technologies, their agency, the agency of the technology used to bring them into scientific discourse, the agency of the scientists, the agency of funding sources, and the agency of other discourses are also part of what speaks in such activities and purified determinations of who is saying what are not possible. Still, as I pointed out earlier, we are bound to endlessly translate the impact of these various agencies and the

relations they generate if we are to have any agency in the co-production of our world and ourselves.

For Latour the proliferation of hybrid challenges to modern notions of identity that define the juridical subject indicate networks of connection that the modernist project both enables and ignores. Latour argues in *We Have Never Been Modern* that modernity depends upon the illusory separation of political and scientific kinds of knowledge, a separation that both encouraged the proliferation of hybrids and ignored their consequences for modern notions of pure identity and presence. Like Haraway, Latour turns to Shapin and Schaffer's work to examine how Boyle's air pump restructured the relations among a variety of discourses to make science the modern source for truth on which rational decisions could be based.

For Latour the value of their work lies in their resistance to dividing the world into the scientific and political spheres in their analysis of the arguments between Hobbes and Boyle. Since both Hobbes and Boyle sought the same kind of political and religious organization and both adhere to mechanist philosophies, Latour argues that the real dispute between them lies in how best to secure those shared goals. He points out how "Boyle and his colleagues abandoned the certainties of apodeictic reasoning in favor of a doxa" while "Hobbes rejected Boyle's entire theater of proof" in favor of a "mathematical demonstration, the only method of argument capable of compelling everyone's assent" (18-9). Their very different approaches to the creation of knowledge generated a single invention, the technologies of inscription that we recognize today as the twin discourses of science and politics.

Latour argues that the dispute between Hobbes and Boyle effectually constitutes the fundamental rhetorical relationships of the modern world, in the same instant reshaping the world by giving birth to the humanist subject, "nonhumanity," and a "crossed-out God" (13). By separating these three realms, the modern period has allowed an enormous proliferation of hybrid forms that can only occur when science and politics are thought of as separate and hybrids as inconsequential exceptions to that separation:

> Boyle is creating a political discourse from which politics is to be excluded, while Hobbes is imagining a scientific politics from which experimental science has to be excluded. In other words, they are inventing our modern world, a world in which the representation of things through the intermediary of the laboratory is forever dissociated from the representation of citizens through the intermediary of the social contract. (27)

Latour argues that the proliferation of hybrids would have been impossible in earlier societies that recognized that every material change is also a social and spiritual change, societies that recognize the agency of things as well as that of humans and that of discourse. What the modern constitution of society has allowed is the proliferation of hybrids that challenge the boundaries of the modern subject / object distinction without offering us any way to control these challenges as they profoundly reshape modern societies.

Because the artifacts and institutions of our modern world are intricately woven from both the political and the scientific realms, all attempts at knowing something about them must consider their positions and functions in these networks. Latour argues that only the discipline of anthropology, once modified to account for the effects of what he calls this "modern constitution," has developed

appropriate methods for such a study of networks. I would argue that other disciplines, including that of philosophy, have developed equally valuable, albeit different, methods capable of achieving the same goal. Latour's text, in a way, rehearses the argument between Hobbes and Boyle, becoming the champion of a scientific approach at the expense of a philosophical one. Nevertheless, Latour's examination of the modern condition clearly demonstrates the important role of blindness and silence in enabling the modern generation of hybrids.

Cross-Disciplinary Networks

One type of hybridization that goes on all the time while being thought of simultaneously as inessential and supplementary to the traditional disciplinary divisions and yet necessary and essential to the functioning of those same disciplines is the cross-disciplinary study of the effects of scientific and technological knowledge. Despite cries against the constructivist challenge presented by science studies scholars, cross-disciplinary activity is often pursued by scientists themselves. In fact, cross-disciplinary study is not really what is being decried in such complaints as those found in *Higher Superstition: The Academic Left and Its Quarrels with Science*, by Paul Gross and Norman Levitt. Rather, what offends them is a particular type of science studies that resists science's claims to objectivity and the modernists' faith in the inevitability of progress through technological advance.

Concerted efforts are often made by scientists to examine the interaction of science and other areas of society. Funding for investigations of the Ethical, Legal, and Social Impact (ELSI) of the Human Genome Project (HGP) is even included in the HGP budget. Of course, such studies have precious little power over the

direction science takes. Rather, the types of projects funded by ELSI work to integrate science and scientific method more fully with other social institutions.

One such project that received ELSI funding is a conference series for judges organized by the Einstein Institute for Science, Health and the Courts (EINSHAC) that offers them the opportunity to study cases involving the boundary issues brought up by genetic reinscriptions. EINSHAC is also developing a video series in conjunction with these conferences as resources for judges adjudicating such cases. Also funded in part by the HGP was the Summer 1997 issue of *The Judges Journal*, a publication of the American Bar Association's Judicial Division that focused solely on the role of genetics in the courtroom. Clearly judges are concerned with the ambiguities brought to the fore by such cases, and scientists are interested in helping to shape the court's use of science.

In fact, new federal rules of evidence allow judges to act as "gatekeepers" for science in the courtroom by allowing them to pick a court appointed expert rather than allowing "hired guns" to offer conflicting interpretations of scientific information. Although not a completely equal partnership in terms of who may speak with legitimacy about scientific facts, the rhetoric of the court system is also having an impact on shaping scientific research. The National Institutes of Health (NIH) Consensus Development Program (CDP), originally designed to bridge the gap between medical research and medical practice by establishing an "unbiased interpretation" of "medical treatments and procedures," is one example (Ferguson 22). The CDP arrives at these "unbiased interpretations" by hosting a conference composed of "neutral" scientists who review the available data and, like a jury, interpret the "testimony" of the data. The process is quite comparable to that of a

courtroom and legal concerns over liability issues are among the deciding factors in its decision making process.

Restructuring the Courts for Biotechnology

While many tend to think of science and law as distinct disciplines related only by their mutual concern for establishing matters of fact, it is this very shared interest in the "discovery" of "truth" that connects these two disciplines in more interesting ways. Each discipline's struggle for the "truth" generates seemingly conflicting methodologies that often bring "truth" into question. Science and law confront each other at both the legislative and judicial levels. Not only is science brought into the courtroom via the "expert witness" and forensic technologies, but the courtroom is brought into science via its property and privacy laws. For example, as I discussed in Chapter 4 the motivation behind hybridization and much transgenic writing is to generate exclusive ownership in plant genetic resources. Developments in genetic research are effecting dramatic changes in legal discourse and court structure while the law is in turn affecting genetic research strategies via patent and copyright law and discourse strategies via science's struggle against the adversarial approach to truth in the courtroom.

The "technological ambiguity of [many biotechnological] inventions under traditional patent principles" has led to the creation of the Federal Circuit Court, the "first experiment in 'national' federal appellate jurisdiction at a level below the Supreme Court" (Burchfiel 3-5). It was established in 1982 as a "congressional response to dissatisfaction with the divergence of the circuit courts in the patent field" and "dismay at the Supreme Court's vacillating standards of patent law and at times open hostility to patents" (6). Moreover, congress chose to create the

Federal Circuit with an express desire to create a "more reliable patent system" for the "sustained economic growth" that would help US companies compete with Japanese and German companies (10). As Kenneth Burchfeil argues in *Biotechnology and the Federal Circuit*, this court was created "as a bold experiment in committing basic industrial policy and competition issues to the exclusive judgment of a single federal appellate court" (10).

From its inception in 1982 to 1989, the Federal Circuit had increased the rate of patent enforcement from 30 to 80 percent (Fowler 218). The Federal Circuit Court has persistently upheld its own policy objectives, even over precedents established by the US Supreme Court. At its inception, the Federal Circuit took its judges from the Court of Customs and Patent Appeals and the former Court of Claims, which made for a court with judges experienced in the intricacies of patent law. Since that time the original judges have been replaced with judges who have "neither the technical background nor any experience in patent law," nor any particular expertise in the sciences of biotechnology or telecommunications that the court was created, at least in part, to provide (13). In the end, the Federal Circuit has not led to the uniformity in patent law that its creators envisioned. In its early days this court has, however, allowed for a proliferation of patents on living organisms and biomaterials unprecedented in previous courts.

Since the formation of the Federal Circuit and the expectation of a pro-patent court, the US Patent and Trademark Office has approved many broadly defined patents that give their filers all rights to the genetic alteration by any means to a particular plant or animal group or to all uses of a biological process. For example, patents have been granted for rights to "all genetically engineered cotton

plants and seeds, regardless of the method used to engineer the plants," "all soybean plants that express foreign gene products," all uses of "novel RNAs, called antisense RNAs, to block the activity of specific genes in any crop," and "the original Harvard mouse patent, which contrary to its reputation contains broader claims to a transgenic subhuman mammal" (Stone 656-8, Burchfiel 32). These broad patents sound very much like the royal privileges granted to printers before the age of copyright protection that I will discuss later in this chapter.

While some of these broad patents have been successfully challenged by competitors or public interest groups, many still stand and the PTO seemed "prone to issuing broad patents" at the turn of the century (Stone 658). Since DNA sequence itself cannot be patented, companies seeking to profit from the Human Genome Project's bonanza of genetic sequence information must come up with potential uses for the genes and gene products they identify. Yet with broadly defined patents, such distinctions are hardly relevant. For example, Mycogen's patent on "any method of modifying *Bacillus thuringiensis* (*Bt*) gene sequences to make them resemble plant genes" so that plants can be engineered to express the *Bt* gene that "produces an insect killing protein" grants them such broad ownership rights that they may as well own that section of genetic sequence (Stone 658). Unless another gene can be found or made to produce the *Bt* protein, Mycogen has a lock on all transgenic reinscriptions of the *Bt* gene in agriculture despite the fact that naturally occurring *Bt* has been used by traditional and organic farmers for centuries to protect crops from insect pests. The risk to organic farmers is the potential loss of their best method of pest protection to newly resistant pests as the general increase in *Bt* protein from this new source applies selection pressure for resistant

insects. Moreover, as a process claim, Mycogen's patent offers them protection from any imported products that contain plant material with the genetically engineered *Bt* protein. Whether chemical analysis can tell the difference between the application of natural *Bt* protein and genetically engineered *Bt* protein depends on whether the plants are engineered with marker DNA to allow identification. One can even foresee the possibility that enforcement of Mycogen's patent could interfere with importation of nontransgenic crops on which *Bt* was sprayed.

Since the Human Genome Project's virtual completion of the sequence map, estimates for the number of genes in the human genome have fallen from 140,000 to around 30,000. This reduction in the number of genes, in combination with the enormous expense of defending patent claims, has led to speculation that "the long-term sustainable growth and economic viability" of the biotech industry is in question. Many biotech company claims about future profits are based on their exclusive ownership of the potential uses for gene fragments, but these fragments may only function in combination with gene fragments patented by their competitors (Claverie 1256). While patenting uses for gene fragments has become harder, patents already issued could make the ownership of uses for any particular gene as complex as the genome itself (Malakoff 1194). With the reduction in the number of genes we expect to find in the human genome and our growing knowledge about how genes interact with each other and with environmental conditions to produce phenotypic effects, the more than 20,500 pending patent applications on potential uses for human genes are now expected to be overlapping claims for the same genomic "territory" and the speculative value of the patent claims of many biotech companies is likely to dissipate. Yet the effect of the tort law they leave in

their wake cannot be underestimated. In 1995, Genentech had "five times as many lawsuits to protect its patents as it [had] products" (Fowler 218), and biotech startups generally spend far more trying to establish tort law that supports the property interests of the industry than on scientific research. For some venture capital behind the biotech startups (such as pharmaceutical companies) establishing tort law regarding the ownership of biomaterials is as much their goal as access to cutting edge research on new products.

Lockian Ideas of Property

In order to understand current debate over the legal status of genetic information and the effect it will have on legal concepts, including privacy, property, autonomy, culpability, and justice, it will be useful to review the birth of copyright law and its relation to the concurrent development of these concepts. As Mark Rose points out in *Authors and Owners*, copyright developed as an outgrowth of the invention of the printing press and the enlightenment's liberal revolution. Rose illustrates how the medieval understanding of manuscript ownership meant one owned the book as one owned an object, and though this included the right to make copies, that right did not imply that one owned the abstract quality of expression recorded on the page.

With the invention of the printing press books could be reproduced more readily, hence they lost their significance as precious objects that were generally copied on commission and gained significance as marketable commodities that had to be sold. Printers wanted to secure monopoly rights in texts in order to guarantee the success of their investment in equipment and materials, so they sought royal privileges that gave particular printers the sole right to print particular texts, types

of texts, or in a particular language. As Rose argues, these "privileges" were based on royal prerogative and were similar to what we would today call patents (9-11).

Rose also illustrates that through the early modern period a text was thought of as a rhetorical move on the part of its author, "less as an object than as an intentional act, a way of doing something, of teaching or delighting" (88). Likewise, for printers a royal privilege meant that they were granted permission to "do something, namely to multiply copies of a particular title," rather than ownership of a particular text (88). Similarly, pharmaceutical and biotechnology companies are today granted patent rights to specific uses of genome sequences, but not to ownership of the sequences themselves, which are defined as the common property of everyone (in the case of bacterial, fungal, plant, animal and sometimes human genomes) or of the sample donor (occasionally in the case of human genomes). Moreover, the system of royal privileges was closely allied with the crown's right to censure its subjects and control the activities of the press, while the modern treatment of "texts as aesthetic objects was," as Rose argues, "commensurate with a system of cultural production and regulation based on property" (13). This new system was based largely on the theories of John Locke, whose classical liberalism was grounded in a notion of self-ownership that challenged the authority of the absolutist state.

Locke generated what Robert Sessions and Jack Wortman have called "the founding story of the modern world" (204). His narrative for the origin of private property, found in his *Second Treatise of Government*, begins with an Edenic "state of nature" that would develop into a "state of war" as goods became scarce if government had not, by consent, been developed to protect private property and

money had not been invented to increase the supply of goods. For Locke, the only way to generate a just society was to base it on the notion that every man owned himself, quite literally as one would a piece of real estate, and hence he also owned the product of his labor. By acknowledging the right of each individual to own himself, Locke successfully argued against preservation of the monarchy's power. He was likewise directly involved in arguing for author's rights to their texts and against the system of royal privileges (Rose 32-33). Today many legal scholars argue for the extension of Lockian self-ownership to the cells of one's body to protect individuals from the abuse of their genetic material and information. I will discuss these arguments and the types of abuse they are designed to protect us from later in this chapter, but first will address how the possibility of citational graft among bodily tissues, genetic sequences, and genetic discourses undermines the bodily integrity on which Locke's labor theory of value depends.

Significantly, although Locke begins "with a radical equality of rights," as Sessions and Wortman argue, he "concludes by justifying a dramatic inequality of wealth, power, and political enfranchisement based on differences in 'natural endowment' (women and people of color are like children in lacking *full rationality*, the crucial ability necessary to handle the responsibilities of ownership) or *character* (poor white men do not deserve wealth or full citizenship because they lack the proper desire to work)" (198). Although Locke's argument for private property reinscribed the inequalities of his day in its justifications for the accumulation of wealth, it also prepared the way for further enfranchisement. Indeed, as many excluded groups fought for and gained recognition as full citizens, Locke's theories concerning the origin and nature of property were used to justify

their right to speak on their own behalf, and hence their right to political enfranchisement. This generally called for defeating the arguments that one lacked full rationality or that a poor character is to blame for one's situation.

Similarly, property law could be used to protect an individual's interest in the privacy and use of his or her genetic information, but it depends on the same insistence on bodily integrity and recognition, with its consequent dynamics of inside and outside, public and private, which are undermined by the very connected nature of the genetic. In fact, some "geneticists speak of 'the family' as the patient rather than the individual" and "58% of geneticists said they would disclose the risk of hemophilia A to a relative without the patient's permission, and 60% said they would disclose the risk of Huntington disease" (Andrews 266). These statistics indicate that the geneticist's decision to disclose confidential patient information is not related to whether the disease is treatable and that more than half view the larger family group (if not the larger society) as their patient.

Few in the western world would quibble with the justice of Locke's assertion of common-law rights to one's own body and the product of one's own labor because our notions of justice are grounded in a sense of ourselves as self-present individuals. A just act is generally understood as one that equitably balances the rights of all parties, and it is the seemingly self-present individual that represents what could be called the "unit of selection" for judging whether an act is just. Alternatively, in some non-western societies the tribal or family group is considered the "unit of selection" for determining right relations, and questions of individual liberty that are central to western notions of justice are irrelevant or subversive to the performance of justice in these societies. The posthumanist

revision in our concept of justice that I wish to propose makes the "unit of selection" neither the atomistic liberal humanist self nor the larger social group. Instead it looks to balance the interests of individuals, groups, and material relations at once by recognizing that all are involved in the co-production of the networks that generate embodiment and meaning in their relational structures. While it will be difficult to negotiate material and semantic distributions on all three levels simultaneously, it is preferable to maintaining the separate spheres of bodily reality and political enfranchisement.

It is also significant for questions of justice that, for Locke, the value of any product is created only when a person applies their labor to natural materials. He argues in the *Second Treatise of Government* that, "it is labor . . . which puts the greatest part of the value upon land, without which it would scarcely be worth anything" (212). This is called the "labor theory of value," and it remains a foundational concept in modern copyright and patent law. As with the notions of "full rationality" and "character" discussed above, this notion that value comes almost solely from human labor rather than inheres in the natural materials themselves served to justify the inequalities and colonial expansions of his day, and often continues to do so in ours.

Moreover, Locke's notion that individuals own the products of their labor, even when that labor is only the act of appropriation, requires that he devalue the raw materials he identifies as the common inheritance of all in order to avoid acknowledging that privatization always takes some potential value from others. His refusal to acknowledge the potential value in raw materials that enables kinetic value to be released through the application of human labor, to borrow a few terms

from physics, reflects the fact that his myth was designed to explain the rightness of existing property distributions.

Indeed, Locke argued that the fundamental role of government is the protection and increase of property, and that in the "civilized" world, which he defined as that part of the world where men had "by compact and agreement" set national boundaries and agreed to use money as the means of exchange, the common property within particular borders was the property of a particular group. This meant that within the "civilized" world one did have to recognize that taking from the common property of the group required payment of some kind. But in those parts of the world where "the inhabitants [have] not joined the rest of mankind in the consent of the use of their common money" the land remains "in common" in a way that makes it available for appropriation without recompense to any group (213). This is a very different notion of common property than the one Locke applies to the "civilized" world.

The distinction, however, reflects less the role of money as a driving force for development, as Locke would have us believe, than it does the structure of property's origin at the start of his argument. Locke describes property's origin as the "original law of nature" via an image of the incorporation of material nourishment into the body (206). He argues that when the "fruit or venison which nourishes the wild Indian" is consumed, it "must be his, and so his, i.e., a part of him, that another can no longer have any right to it" (205). Property originates in recognition of a body and increases through an act of incorporation into that body, whereby the self-identicality of that body is taken as the equivalent of property in the self and the incorporated material.

Viewed through the "labor theory of value," individual bodies and governmental bodies recognized by contractual agreements may appropriate materials from the common store of mankind without diminishing the property rights of others. Likewise, national boundaries that are not recognized by contractual agreement with western governments do not constitute a body, and therefore cannot own property. Within such an argument, the only truly recognized commons are those protected by recognized national boundaries, for only then is the potential value of raw materials acknowledged as the property of the group. "Mankind" is emphatically not recognized as a composite body with shared ownership of the world and Locke's origin story refuses to recognize God's original gift as property while at the same time using the name of God and God's gift of the world to help secure the right to property.

The kind of biotechnological prospecting among humans that I discussed in Chapter 4 challenges Locke's labor theory of value with situations where the potential value lies not in the fruit of the vine nor the sheep of the field, but rather in human bodies who become the source of raw materials for the kinetic value produced by the labor of other humans and their technologies. As I have said, Locke's notion that individuals own the products of their labor, even when that labor is only the act of appropriation, requires that he devalue the raw materials he identifies as the common inheritance of all in order to avoid acknowledging that privatization always takes some potential value from others. Yet when that devalued raw material is, in fact, the very body of another human being, the relation between Locke's labor theory of value and the exploitation of one's others is made more apparent.

Remembering that labor can be merely the act of appropriation, surely a situation which makes the very body of some humans into the commons available for the appropriation of others calls into question Locke's system. As with Locke's exclusion of those whom he considered without full rationality or good character from those entitled to own property, we must be careful of distinctions that would make some people into the commons available for the creation of exclusionary property rights of others. Since the person who is made into a source of raw material must have owned his "own" person, having already had the right to give or sell other parts of his "self," including his or her internal organs and his or her very "life" as time sold into wage labor, those who appropriate cells from the bodies of others in order to create private property for themselves have surely taken something valuable from another individual. Without the sample they would have no immortalized cell-line for future study nor any patentable biochemical compound or process.

While the race to patent potential uses for gene sequences has created challenges for the Federal Circuit and the PTO, biotechnology has brought generalist state courts many challenges of their own. Infamous among these are the cases of *Moore v. Regents of the University of California*, *Davis v. Davis,* and *Hect v. Superior Court (Kane)*. All three of these cases confront the courts with questions of whether particular types of genetic material are alienable property. Thomas Moore was a patient being treated at the UCLA Medical Center in 1976 for hairy-cell leukemia. Dr. Golde, his physician, "discovered that Mr. Moore's spleen cells produced blood products that could be commercially valuable" in response to his drug treatment regimen (Roche 37). He removed Moore's spleen, ostensibly in the

course of his treatment, and had Moore return to the UCLA Medical Center at least twice a year for seven years in order to "provide numerous bodily samples to Dr. Golde and his research associates" (37). When he discovered that his physician "had entered into a contract with Genetics Institute for at least $300,000 in exchange for development of the cell line and products derived from . . . Moore's cells, he sued to recover what he claimed to be his fair share in Dr. Golde (and the University's) profits" (38). The California Supreme Court decided that Moore did not have a property interest in his bodily tissues once they were removed from his body, arguing that although he did not have cause of action for their "interference with his possessory and ownership interests in [the] personal property" of his cells, he did have cause for their failure to inform him of the conflict of interest which resulted in a lack of informed consent and a breach of fiduciary duty (Litman 22). As Patricia Roche has argued, in specifically trying to avoid making such biological specimens into alienable property, the court in effect made his cells into alienable property for everyone but Thomas Moore.

Both the *Davis* and the *Hect* cases concern establishing the boundaries of acceptable reproductive practice using biotechnology. In the case of *Davis v. Davis*, a divorced Tennessee couple sued over custody of their cryogenically preserved embryos. The Davis's had been planning on having children via *in vitro* fertilization (IVF), but divorced before the implantation procedure. Mary Sue Davis sought custody "so that she could donate them to someone else for implantation" and "Junior Davis objected to having genetic fatherhood thus thrust upon him" (Dworkin 82). The trial court awarded custody to Mary Sue, but the Tennessee Supreme Court overturned that judgment by deciding that the embryos

"could not be treated as persons, entitled to a determination of what was in their best interests, or as property, to be divided like any other marital property" (83). While "both the ex-husband and the ex-wife had interests" in their embryos, the court decided that "the burden of unwanted fatherhood was greater" (83). The court also indicated that for the future the disposition of embryos "should be decided according to the preferences of the progenitors," however, if they do not agree, "the party wishing to avoid procreation should prevail, at least if the other party has a reasonable chance to achieve parenthood by some other means" (83). This seems an equitable and fair decision, and it is capable of being a fair and equitable decision precisely because the court concerns itself with recognizing and balancing the competing interests of those we recognize as judicial bodies with standing in the court. It also leaves open the possibility that what bodies or what values count to our society could change and alter decisions such as this one.

In *Hect v. Superior Court (Kane)* "the California Court of Appeal concluded that cryogenically preserved sperm was a 'unique' category of 'property', which properly formed part of a decedent's estate and over which the decedent had an interest in the 'nature of ownership'" (Litman 25). Hence the deceased's cryogenically preserved sperm could be divided among his two adult children and his girlfriend according to the percentages for the division of his personal property that he had listed in his will. His children had sued to keep his girlfriend from gaining access to his sperm and using it to create more heirs to his fortune. But since "California's public policy does not prohibit either post-mortem artificial insemination or artificial insemination of unmarried women" the trial court ordered

that his girlfriend receive her 20 percent according to the allocation of property in the deceased's will.

Lessons From the "Monstrous" Hybridizations in Literature and Life

Mary Shelley's *Frankenstein* established a powerful set of social icons that remain active in current discussions of science, particularly biotechnology. The hubristic Dr. Frankenstein is an archetype frequently reinscribed in news accounts of biotechnological invention, and the bain of many scientists who fear an uncritical rejection of their work. Shelly's novel is also a text pregnant with intertexts whose lineages have been traced by many critics. Alan Bewell's analysis of the role of nineteenth century obstetrical discourse in the novel focuses on it as a reinscription that offered Shelley an empowering aesthetic. As Bewell argues, it had been common for monstrous births to be explained as the result of the "mother's ardent gaze on an image," an image that came between her and her husband at the moment of conception. Since the "form-making power of the seed" was thought to originate in the male, this notion that the female could reshape the infant through a mimetic imaginative faculty was both threatening and, as Bewell argues, potentially empowering because the force behind this refashioning of the fetus is female passion. While this notion was no longer thought valid at the time Mary Shelley wrote *Frankenstein*, it was recent enough for her to have been aware of it, and Bewell convincingly argues that she incorporated it into her description of Frankenstein's midnight labors in the charnel houses and graveyards where the material for his monster originates. Using another reproductive trope, Shelley also makes the process of literary creation analogous to the production of children. She accounts for her conception of the idea for *Frankenstein* in terms thick with

reproductive metaphors, and in particular those associated with the notion that women's imaginative faculty reshapes the materials given as an author reshapes received ideas from intertexts (121). Shelley's novel engages a theoretics of bodily and social (re)production based in this notion of textual creation and embodiment as composite, stitched together out of the bodies of others like the pages of the book or the body of her monster.

Again, one of the many difficult sites of boundary formation confronting the courts today is new reproductive technologies and their consequences. The 1993 California Supreme Court case *Johnson v. Calvert* challenged the very definition of motherhood by presenting the court with biological parents and a gestational surrogate battling over custody of the child. The court turned to the paradigm of intellectual property law to decide the case, finding that the child's mother was the woman "who was the 'originator of the concept' of the child" (Rose 217). This recalls "the early nineteenth century figure of the romantic author," precisely the notion of authorship as the result of wholly original genius that Shelley's novel rejects. In *Johnson v. Calvert*, the court decided for the couple who hired the surrogate as originators of the idea of the child. The dissenting opinion in the case outlined concerns over the devaluation of the process of gestative labor and the equation of childbearing with the simple warehousing and delivery of goods. The only woman on the court, Justice Kennard would have based her decision on existing child custody standards regarding the child's "best interests" rather than try to establish motherhood on such grounds.

As Mark Rose argues in "Mothers and Authors," Justice Kennard's dissent "can be understood as an objection to the masculine appropriation of childbearing

implicit in making intellectual conception the essential act in procreation" (226). Shelley's novel performs precisely this masculinist, intellectual usurpation of female procreative power in what is to be a lesson in developing just relations. In Shelley's vision such a usurpation is self-destructive in its refusal of the role of nurturance–which is precisely what the court in this case explicitly chose to devalue in order to privilege the role of intellectual conception, genetic kinship, and the nuclear family. Of course, they could have arrived at the same result while arguing for nurturance and the child's future "best interest" as Justice Kennard did, but the majority's emphasis on children as reinscriptions of their parent's genetic signature and as the property of those who conceive them denies both the child's and Johnson's positions as a juridical subjects with contending interests that must be weighed.

Reproductive technologies transform women's labor in childbirth into a frontier for engineered possibilities and the generation of capital. By separating the stages of conception, gestation, and birth and introducing the perspective of the engineer, these technologies can certainly be liberating for many women, but existing pressures surrounding reproductive choices, as well as current distributions of power and capital, affect the material implementation of these new technologies. In order to develop their liberatory potential while resisting such pressures and the effects of capital distributions, we must examine reproductive technoscience as an important site of boundary articulation and become involved in generating legal structures that encourage just flows in biotechnological power. Significantly, there is tremendous confluence between current debate about the ethical choices surrounding these new (re)productive technologies and those surrounding the

establishment of western copyright and patent law. An examination of this confluence will help us understand what narratives motivate current formations of the juridical subject and may indicate how we might want to alter those narratives.

Signatures in the Inscriptions

In his analysis of the formation of copyright, Rose identifies important connections among notions of propriety, privacy, and property that impinge on current debate about genetic information and the construction of the juridical subject. To begin with, the legal right to privacy was constructed from many of the same arguments used to create copyright in that both rested on a notion of propriety that Rose illustrates is based on a conflation between one's "own" self and "ownership." Indeed, the original statement of a right to privacy in the United States is based in the precedent established in *Prince Albert v. Strange* (1849), an English Chancery case that determined a common-law copyright exists for authors and artists prior to publication (139). This decision meant that the creator of a text or artwork was legally recognized as having the right to decide whether their work will be published and by whom.

The propriety of controlling one's textual signatures eventually became property with the creation of authorial copyright, and could do so with genetic signatures as well. As Rose argues, "copyright does more, then, than govern the passage of commodified exchanges across the boundary between the private sphere and the public; it actually constitutes the boundary on which it stands" (141). It is one of the phantasmagoric blades the court must wield in carving out the distinctions that create the boundaries of the juridical subject. As Rose illustrates, "the author was recognized as an individual with an interest in the status of his

name and reputation before he was recognized as a fully empowered figure in the marketplace" (18). And while this recognition of an interest in controlling whether one's papers were made public was far from equivalent with recognition of an alienable property right to those works, "the right to control publication has economic implications" (18).

Similarly, today tort and legislative responses to concern over the potential for abuse of genetic information have emphasized the right of patients and blood donors to determine how their samples may be used and who may have access to their genetic information and medical records, but pressure from the biotech industry has often kept judges and legislators from making them the property of donors. In 1995 alone, "at least 18 bills to regulate the uses of genetic information in employment and insurance were introduced before at least 13 state legislatures" and "statutes to control or limit the use of genetic information in certain ways were on the books in 14 states" (Reilly 369). The most obvious example of the effect of industry pressure is the fate of the New Jersey bill, which was conditionally vetoed by then governor Christine Todd Whitman after having been unanimously approved by both houses of the New Jersey legislature. After meeting with representatives from the Biotechnology Industry Organization and the pharmaceutical industry, the provision she expressly wanted removed from the bill was the statement that made genetic information and samples the property of the donor. Both Colorado and Oregon have passed legislation that expressly grants property rights to the DNA sample source. Many other states have enacted legislation to protect privacy interests in genetic information but not gone so far as to grant property rights. While most laws governing genetic information have been designed to protect the

privacy of the donors, one troublesome example from Alabama should be noted. In that state the DNA data bank for convicted criminals "specifically authorizes the use of [these] samples . . . for 'educational research or medical research or development'–an authorization that would presumably encompass behavioral research into, for example, genetic predispositions to violence" (McEwen 238).

The battle of the booksellers over copyright was a border conflict much like the one currently being waged over genetic material and information. Our proprietary control over our "own" bodily boundaries are very much at stake in genomic technoscience, and if we choose to acknowledge a right to control the use and distribution of our genetic information and bodily substances, there are economic and legal consequences that will need to be addressed. Since future narrativizations of human origins, qualities, and potentials will be signed with our bodies, we all have a right and a responsibility to direct the inscription of such narrations. Currently the relations of property being established in US courts are often challenging those rights and we are generally neglecting that responsibility.

In "Signature, Event, Context," Jacques Derrida examines the function of the signature and its relationship to the iterability of writing. He offers the following explanation of the simple act of signing one's name:

> Effects of signature are the most common thing in the world. But the condition of possibility of those effects is simultaneously, once again, the condition of their impossibility, of the impossibility of their rigorous purity. In order to function, that is, to be readable, a signature must have a repeatable, iterable, imitable form; it must be able to be detached from the present and singular intention of its production. It is its sameness which, by corrupting its identity and its singularity, divides the seal. (20)

Bodies are likewise formed via the iterable processes of genetic and biochemical systems which are the cumulative result of the stochastic accretion of pattern. Iterability structures our bodies as well as our language. Both can be engaged in processes of citational graft that produce by reproducing difference. This bodily iterability undermines Locke's theory for the origin of property by undermining its foundation in the self-ownership of a whole and self-identical organism, namely the liberal humanist individual. The separation between one's "own" self and the ownership of one's body parts that has already occurred, even before the advent of biotechnology, undermines the self-identicality of self-ownership and the ownership of one's "own" labor, and of the products of one's labor, that is foundational to Locke's justification for the labor theory of value. In fact, that separation, the possibility of alienation from one's body, one's labor, and one's products is what makes capitalism possible.

And yet, within the liberal humanist tradition, if we each own "ourselves," surely we each own our bodies. Recognition of that ownership in a variety of systems of exchange, from the gift of organs for donation to the sale of hair for expensive wigs, represents our cultural acceptance of self-ownership as the basis for just relations. As I have shown in Chapter 2, debates over which unit of selection should be used as the hero in narratives of evolutionary survival are based in a separation of the public and private that is irrational as a basis for understanding what happens with DNA. As Evelyn Fox Keller argues in *Secrets of Life / Secrets of Death: Essays on Language, Gender and Science*, this separation of public and private values in the narration of evolutionary dynamics is undermined by the fact that natural selection must be said to act on the gene, the organism, and the species

simultaneously. Likewise, Locke's labor theory of value is undermined by the fact that value derives from the raw material, the labor applied to it, and from the consumption of the product produced. To claim otherwise is simply to engage an imperialist rhetoric in which acquisition without permission or recompense does not signify theft.

Western culture, particularly that of the United States, has been based on atomistic liberal humanism which makes individuals rather than groups the "unit of selection" for determinations of justice. Yet biotechnology presents the courts with circumstances where the boundaries of the juridical subject must be defined in the process of determining just relations, and the values chosen in setting such boundaries are made obvious and must be justified in the disposition of the case. Moreover, if the public feels such decisions do not reflect their wishes, they can influence legislators to create laws that are more consistent with their views. The legal and legislative systems offer avenues for political action and the construction of a society in keeping with the values of the community. If we want some other relationship besides the one of property, we must regenerate a logic of the commons that extends to all. Our patent laws should no longer reward the mere acquisition of biomaterial nor grant broad patent claims. It should include mechanisms for sharing ownership with all those who contribute or find ways to better distribute benefits so that medical treatment for patients and claims made from DNA data banks are more responsive to the interests of patients and donors.

Justice and Distributed Agency in a Posthuman / Nonmodern World

As Haraway argues, it is not a choice between salvation or apocalypse, but rather the challenge of engagement with the processes of technoscientific knowledge

production that we must face. Her reclamation of the modest witness from its role as the guarantor of scientific fact is a strategic move designed to transform the act of such witnessing from the "verification" of "fact" to the ongoing examination of a relationality in which one is necessarily implicated. What is at stake is the distribution of power via the structure of legally recognized embodiment and relationality. The borders of what will count as a juridical subject within this contractual relationality is crucial to the possibility of justice. These borders profoundly affect lived possibilities, but since they are never stable we have the opportunity to effect change by reshaping them. Moreover, the performance of justice can only occur when the law equitably balances the interests on all three "units of selection" simultaneously, individuals, societies, and environments.

The increasing confrontation between biotechnology and the ethics that structure modern constitutions and courts are one area where we might help reshape such borders in a way that increases the possibility of justice by offering a post-humanist basis for ethical discussions. Much like Locke's efforts to weaken the monarchy's hold on its subjects and empower the modern juridical subject by shifting the defining relationality of property, we have an opportunity to reshape that juridical subject's boundaries by undermining the reliance on a juridical subject based on liberal humanist ideology and its narrative of original genius. By moving from copyright and patent law based in Locke's "labor theory of value" to those based in a definition of value that recognizes the role of material bodies and embodiment as agents in the production process (rather than simply as the raw material for capitalization), we can increase the likelihood of justice. This is

especially important in an age when the commodity may become, quite literally, our bodies and body parts.

CHAPTER 6
EPILOGUE: JUSTICE IN THE AGE OF DISSEMINATED AGENCY

> *The object that sits before the subject and the subject that faces the object are* polemical *entities, not innocent metaphysical inhabitants of the world. The object is there to protect the subject from drifting into inhumanity; the subject is there to protect the object from drifting into inhumanity. But the protective shield of factishes has disappeared, and the Body Politic has been rendered impotent.*– Bruno Latour, *Pandora's Hope*

> *It was feasible to be an anti-fetishist when facts could be used as destructive weapons against beliefs. But if we now speak of factishes, there exist neither beliefs (to be fostered or destroyed) nor facts (to be used as a hammer). The situation has become much more interesting. We are now faced with many different practical metaphysics, many different practical ontologies.* – Bruno Latour, *Pandora's Hope*

The economies of scientific production are intimately linked with the economies of cultural production, and both affect lived bodily realities in ways that demand critical attention. Even as new technologies challenge current definitions of what it means to be human, they do not do so in a vacuum. They are shaped by the gendered, classed, and raced networks of thought and material relations currently shaping the body of the culture that produces them. And that body determines, through funding strategies and legal structures, and is determined by, through new

effects each will have. This constructivist position on scientific knowledge does not mean that those nonhumans that scientific activities socialize into our collective networks do not also affect the knowledges science produces, it just means that one cannot claim that theirs are the only agencies activated by scientific study.

No method of producing efficacious knowledge can avoid moving from within these networks. Nor can any individual or social group. The stochastic accretion of pattern in our thoughts, discourses, sciences, economies, etc. are the very condition of possibility from which we continue the ongoing co-production of our networks and ourselves. Since we come into being through the stochastic accrual of biochemical, linguistic, economic, and other patterns of relationality, our humanness is already a part of these systems and determinations of justice can only be made from within the values already available in these networks. The citationality of these patterns and the elements of their composition do, however, make both recitation and revision possible. While both complete fidelity and complete revolution are impossible, significant change based on a concerted adherence to the values associated with a just and equitable balance of interests in any given situation could bring us to a reinvigoration of the commons that would increase the opportunities for justice.

I have tried to argue for a shift in what I call the "unit of selection" for determining just relations that addresses the balance we need to achieve among the interests of individuals, groups, and environments. This move away from the atomistic liberal humanist subject as the fundamental subject for whom just relations exist is based in a recognition that every individual's interests intersect with the interests of their others, including both other humans and other

nonhumans. We already recognize the value of nonhuman others via legally protected sensitive environments whose maintenance is judged more valuable than the unchecked development of human landscapes and local job creation. We already have legal protections in place for many animals that punish humans for unnecessary cruelty and negligent care. Such laws already recognize that maintaining just relations includes balancing the intersests of humans and their nonhuman others. What I propose is not revolution but further evolution of an ethics of ecology, one that recognizes the effects of property law on the possibility of achieving just relations.

The connections among us that undermine an ethics considered solely in terms of individual rights and freedoms have never been more apparent than with genetic information and concerns over protecting the privacy interests in such information. When an individual is tested for genetic illness, the results are relevant for their family members as well, and deciding where the boundaries of privacy lie challenges full adherence to individual liberty as the sole basis for determining just decisions. Alternatively, basing genetic privacy laws on a recognition of the family as patient challenges our notions of fairness as well with cases that undermine the value of individual humans, such as in the case of one mother who wanted her two sons tested for the Huntington's gene because she could only afford to send one son to college (Andrews 263). The challenge for lawmakers and courts will be to weigh such competing interests within an ethics of care and compassion.

In calling for an amodern re-cognition of the co-production of humans and nonhumans, Latour hopes, as I do, to open the field of scientific activity to the active participation of us all so that its effects on legislatures and courts will also be

shaped by the needs of the community and all its members. The vision of a posthumanist scientific activity that he sketches at the end of *Pandora's Hope* calls for the incorporation of the agora in that activity, but also tries to sooth the fears of scientists that such inclusionary practices would appreciably change scientific activity. In tyring to convince scientists that their activities, when defined as socializing nonhumans into the collective, would not be threatened by this inclusionary practice, Latour underestimates the consequences of admitting that the political has always been part of scientific activity. The changes he and I propose will have consequences for scientists, but they will not stop science as an institution in the sense that scientific activities will still be used to socialize nonhumans into our collective networks.

Latour argues that it is the insistence on or confrontation with the subject/ object dichotomy that has separated science and science studies, and that instead of doing battle within the subject/object dichotomy we "should not even try" to overcome it since "all attempts to reuse it positively, negatively, or dialectically have failed" (294). Moreover, he calls the subject/object divide an inherently polemical relation that exists ostensibly so that the "object [will] protect the subject from drifting into inhumanity" and the "subject [will] protect the object from drifting into inhumanity" (294). But this divide "renders the Body Politic impotent" by forcing a choice between reality and fabrication that makes truth simultaneously necessary and ultimately unavailable for determinations of justice (294). What is central to the pursuit of justice (rather than the pursuit of truth or truths) is not the subject/ object dichotomy and arguments about where one stands in relation to it. Indeed, these arguments generally keep us from addressing the

questions that matter by putting questions about the accessability or inaccessability of truth in its place.

Latour's proposal for escaping this polemical dynamic that undermines our chances for real democracy is a redefinition of objectivist truth into a nonmodern truth that accepts the agency of saligrams and recognizes reality as the product of a network of material, spiritual, and social relations. What makes truth the central concept in need of change for Latour, however, is its use as the basis for determinations of justice. Rather than turn to the question of what makes knowledge true, what we need to concern ourselves with is what makes networks just. The justification for this shift is not only that the accessibility of any truth that claims validity beyond its network has been so thoroughly and successfully challenged, but because we generally agree that this should be the goal of civilization. How to achieve the goal remains the question we live by.

In the long history of human civilization there is clearly nothing so common as man's inhumanity to man. There is also within that same long history the equally common cooperative venture that brings out what we generally think of as our humanness. How to get more of the latter with less of the former is the goal. What matters is how we build our collectives, and what agencies we account for helps shape the construction. For Latour, the only two relevant questions are "how many humans and nonhumans are to be taken into account?" and "are you ready, and at the price of what sacrifice, to live the good life together?" (297). I have tried to show that what is central to these questions, even to the decision of how we are to determine truths, is our concept of justice and that one of the most important areas to address in any attempt at reconstructing the collective is patent law, with

all its implications for material distributions. Hopefully we can begin to live the good life together when we stop sidestepping the question of justice.

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BIOGRAPHICAL SKETCH

Angela Harrison Bacsik received her Bachelor of Science in public relations in 1986. From 1986 through 1989 she worked for the American Cancer Society as Executive Director of the offices in Brandon and Plant City, Florida. In 1989 she returned to school to pursue an interest in literature and in 1991 she received her Master of Arts from the University of North Florida. While there she met Dr. Samuel Kimball, who served as her committee chair and introduced her to the idea that she should pursue the Ph.D. After receiving her degree, she married Tom Bacsik, whose patience and love would make future educational endeavors possible. From 1991 through 1993 she worked for the American Culinary Federation's Educational Institute as Director of Development. From 1993 through 1994 she worked as Assistant Director of Volunteer Jacksonville, Inc., after which she again returned to school to pursue a Ph.D. at the University of Florida. In 1999 she gave birth to the brilliant and fabulously entertaining Alexander. In early 2002 she gave birth to the beautiful and equally precocious Nicole. Shortly thereafter she managed to finish this dissertation with help from the "village" of grandparents it takes to raise a child (or a dissertation). She looks forward to the opportunity to write short fiction and screenplays as well as to continue the philosophic study and teaching of the cultural and linguistic circulations engaged by both literature and science.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

John P. Leavey, Chairman
Professor of English

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Phillip Wegner
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May 2002

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